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THE TRAINING OF MECHANICAL ENGINEERS.

THE subject of the training of the mechanical engineer has lately been discussed in the columns of the *Engineer*. Our contemporary has pointed out what most young men do not appear to realise, that the world is not waiting impatiently for the many students, as they drop out of the technical college, to step into situations at £500 a year right away. An average of £50 is far more likely to be the first remuneration offered. The trouble with students is, that too often they are not taught anything of the commercial side of their profession—nay, they are carefully shielded from it. In our own young days, when every steam engine we were able to see was different from any other in style or size, it came as a disagreeable surprise to find that these noble machines were made on certain patterns, that the beam of one size or power of engine would be made to do duty for an engine of a different power, perhaps, with a little lining up of the flanges, and that most engines were made from a more or less scratch lot of patterns at as small an expense as possible. This sort of thing is a shock when first encountered. The young mind should, however, soon recover from the shock, and realise that makers of steam engines and boilers are not doing business for fun, but for profit. The arguments of the *Engineer* ought to apply to electrical students, but it is a fact—possibly an unfortunate fact—that the student's knowledge of electricity has enabled very young and inexperienced men to secure responsible situations very much more easily than they would have done had not the electrical machinery industry gone ahead faster than the manufacture of experienced men.

While the fault of the training of the mechanical engineer has been in its narrowness and its neglect of the commercial side, that of the electrical engineer has been rather in the neglect of mechanical engineering, and hence there has grown up the reproach that the mechanical engineering of light and power stations has sometimes been not all that could be desired. The neglect of the commercial side of engineering is occasionally made painfully evident in the absolute want of appreciation of the cost of an undertaking, and results in rash and unnecessary expenditure on expensive plant where there is no good cause to justify it.

The ignorance or neglect of commercial requirements has for a long time been the predominating characteristic of the so-called Westminster class of engineers—a class who have become dissociated in a great measure from practice—some among them having risen and made their name in connection with public works, on which the real estimating has been done by the contractor; it has come about that mechanical men have been accepted as engineers who have perhaps served chiefly under these men, and so there is a distinct class of engineers who have become quite separated from the commercial side of things, excepting only that they

have duly realised how much the amount comes to at 5 per cent. While trade was so overflowingly prosperous, this sort of engineering high priesthood was more or less patiently endured, but we are now exposed to competition from America and other countries where this sacerdotal burden is absent, and the leading spirit is commercial, and it is more necessary that engineers should be brought up with the commercial end in view.

The Royal Technical Institute of Salford has broken the ice in respect of students, and proposes a course of ten lectures, commencing on January 25th next, to include the working out of a few examples in estimating for general engineering, engines, boilers, &c., repairs and breakdowns. Materials in common use will also be dealt with, and we may hope that something will be taught in respect of their commercially obtainable dimensions and the extra cost of extraordinary sizes. There will be information on the allowances to be made on forgings and castings. The importance of good and accurate castings should be pointed out, as it means cheap machine work if the castings are pickled, while in a forging it may be cheaper to machine off than to forge too close. Here, again, comes in the question of powerful tools to do this.

Indeed, there is no line of demarcation between technical and commercial knowledge, but a gradual shading off and overlapping. How many students in the shop learn the sizes of the lathe cones or spindle, or the speed of revolution, or go into the cutting speeds on cast-iron, wrought-iron, steel, or brass from actual observation on running examples? We do not believe in premium apprentices very much, but when they are in a shop they should work; but if we were now premium apprentices we should certainly feel ourselves justified in leaving our own special work several times a day to measure up speeds on various classes of work. As regards prices, a good deal can be picked up by the student from makers' catalogues. Any student can compare the prices of a line of engines of similar type, and endeavour to trace a curve or formula to connect prices and dimensions.

Materials, and where to buy them, may be learned from the advertising pages of the various technical journals, and we think there is an opening for some good man who, without any further knowledge of mathematics than the simple rules, could teach something of engineering practice along these or parallel lines, so as to prepare the student for the kind of thing that he must encounter in after life.

The *Engineer* complains that the Salford course is spoken of apologetically as suited to foremen and draughtsmen, and asks, Is the engineer proper to be the only man of all who must not be taught anything useful? The fault lies largely with the professors in the schools and colleges, some of whom appear to lose touch with practice altogether, and to aim merely at producing books of more or less abstruse mechanics wholly unconnected with practice.

Selective Wireless Telegraphy.

Judging from a letter of Prof. Fleming, published in the *Times*, Marconi appears, at last, to have solved the problem of tuning the receiver to the transmitter in his system of wireless telegraphy. The experiments, described by Prof. Fleming, were conducted between two stations 30 miles apart, the one near Poole, in Dorset, and the other near St. Catherine's, in the Isle of Wight. Mr. Marconi's latest appliances at these two places are so adjusted that each receiver at one station responds only to its corresponding transmitter at the other. Two messages were sent, simultaneously, from St. Catherine's by the two transmitters, and each message was recorded separately in Morse signals by its own proper receiver at Poole. The power of each receiver to select its own message and refuse all others was still more strikingly illustrated by connecting both receivers to one vertical conductor 40 feet in height. An English and a French message, simultaneously received on the single wire, were separately recorded by the two receivers. Mr. Marconi appears also to have made an important discovery which will lead to the abolition of the somewhat inconvenient long vertical conductor. According to Prof. Fleming, messages received from a transmitter 30 miles away were recorded by an instrument in a closed room merely by the aid of a zinc cylinder 4 feet high placed on a chair. All these remarkable results obtained by Mr. Marconi appear to be opposed to early experience in wireless telegraphy. It was German experimenters, we believe, who asserted that no tuning could take place between conductors connected to earth; and also that the vertical conductor was more efficient the smaller its diameter. Theory, however, would appear to support Marconi's latest results, since the superficial distribution of the rapidly alternating currents would indicate an increase of its surface and consequent reduction of resistance to the oscillations as being advantageous. The detailed description of his apparatus promised soon by the inventor will be awaited with interest.

Opening of the Poplar Electricity Works.—The electricity works which have been erected by the Poplar District Board of Works at Glaucus Street, Bromley, were opened on Monday evening. The chairman of the Electricity Committee, Mr. A. H. Valentine, made a general statement regarding the undertaking, and the chairman of the Board, Mr. James Morton, switched on the works' lighting. Mr. Valentine then switched in the main generator, and Mr. Sydney Buxton, M.P., switched on the supply to the district and to the public street lamps. The undertaking, which has cost £100,000, has been carried out under Mr. Alfred Blackman, the electrical engineer and manager, who designed the system. The station plant comprises four Babcock boilers with chain grate stokers, and two Belliss-Mather & Platt direct-coupled generators, with a separate condenser to each engine. Each set will give 454 amperes at 570 volts at 380 revolutions per minute. The cables, street arc lamps and posts, &c., have been supplied by the British Insulated Wire Company. Street lighting is a very important feature of the installation. On Monday night 10 miles of streets were electrically lighted with arc lamps, and as soon as the necessary connections are made, 17 miles are to be lighted by fitting up the old gas lamps for electricity. Mains have been laid throughout 30 miles of streets, which means about half the streets in the district. Applications have already been received for 5,000 8-C.P. lamps for private consumers, and, in addition, 46 H.P. has been applied for for motive power purposes. Penny and shilling-in-the-slot meters will be placed in consumers' houses where required, and the National Electric Wiring Company is at work in the district. Mr. Buxton, M.P., delivered a speech in which he congratulated Poplar upon having carried out the scheme as a municipal undertaking. Judging from the remarks of one or two of the speakers, Mr. Blackman's services as electrical engineer are very highly appreciated.

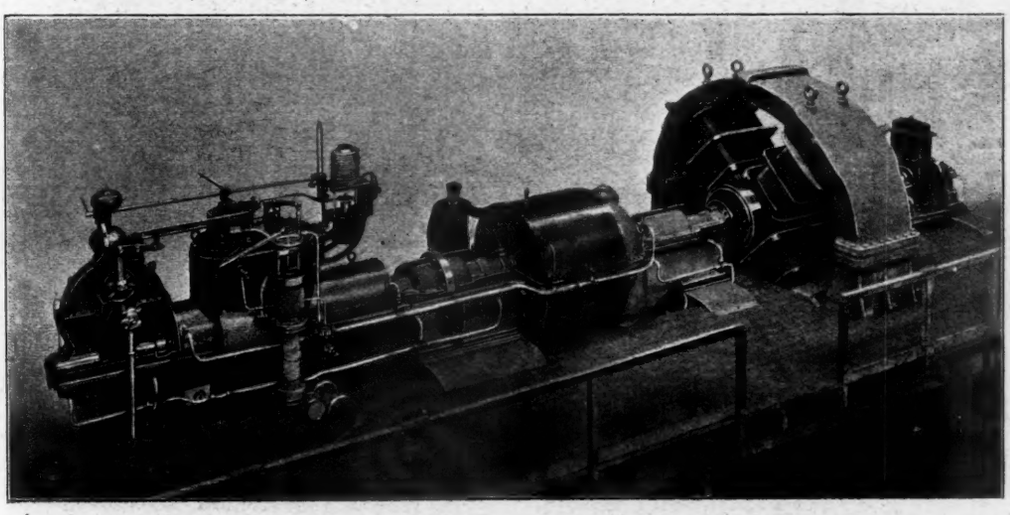
STEAM TURBINE AT ELBERFELD.

We illustrate one of the 1,000-kw. Parsons steam turbo-alternators which have been put down in Elberfeld central station, Germany. The alternator generates three-phase current at 4,000 volts, 50 periods, when running at 1,500 revolutions per minute, and with a power factor of 0·8, the output is 1,000 kw.

Before the set was accepted, a very complete series of tests were made at Messrs. Parsons' works in the presence of W. H. Lindlay and Profs. M. Schröter and H. F. Weber. The results are given in full by the *Zeitschrift des Vereines Deutscher Ingeniere*. At the average pressure of 162 lbs. per square inch and 14·3° of superheat, the following results were obtained :—

Output in kilowatts.		Pounds of steam per kilowatt-hour.
1,190	Overload	19·3
995	Full load	20·1
745	¾ load	22·2
409	½ load	25·4
246½	¼ load	33·8

With the electrical governor, sudden changes in load of from 12 to 62 per cent. gave an average variation in E.M.F. of 1·1 per cent.



Steam Turbine at Elberfeld.

The drop of voltage on increasing the load from zero to full non-inductive load, the speed and excitation remaining constant, was only 1·02 per cent.

After six hours' run the rise of temperature was not to exceed 40° C. Only the core exceeded this figure, and by ventilation it will be brought down to under 40° C.

It would be interesting to compare the above steam consumptions with figures taken for, say, two years' time so as to give an idea of the sand blast action of steam. Perhaps Messrs. Brown, Boveri & Co. who, we understand, are now largely interested in the success of the Parsons steam turbine on the Continent, will take the necessary steps to thoroughly test this interesting point in steam turbine design.

THE ELECTRICAL ENGINEERS R.E. VOLUNTEER CORPS.

In our issue of April 27th last, we gave a description of the equipment taken out by the above corps to South Africa. In the same article we gave a rough outline of the uses to which a corps of this description would in all probability be put in warfare.

Now that the war is practically ended, and the corps is likely to be shortly returning, it will be interesting to briefly review some of the work to which it has been put.

We have had the privilege of reading a series of letters sent home by Major Crompton, from which we have been able to gather an idea of the progress of the work of the corps at different periods.

An extract from one of these letters dated Kopjes, May 30th, runs as follows :—

> The first job for Lloyd's party was at Bethulie Bridge, they supplied arc lights in several places, and hauled the train about satisfactorily. They also had some projector practice. Then followed similar jobs at Bloemfontein, Vet River, Zand River, and Rhenoster. I was with them at the last two places. The plant that has worked well has been the small arcs. Our men are getting quite smart. At Rhenoster we got the order to get the engine off the truck at 3 p.m. Did so, and ran 2½ miles over the veldt to the "Break." Fixed up six arcs, and had them lighted at 5.15 running 12 hours without a hitch, and I believe in other cases equally smart times have been made.

This work of repairing the line with the reconstruction trains was continued right up to Pretoria, the repairing party being enabled to work at night as well as in the day time.

On the night of June 14th, the two reconstruction trains were attacked by the Boers under De Wet. These same Boers had a few days previously captured the Sherwood Foresters at Rhenoster, and also a company of the Railway Pioneer Corps at Roodeval. We have learnt from one of the latter, who was taken prisoner, that the Boers numbered about 1,500.

About 2 a.m. B train, which was distant about half a mile from A train, was just starting northwards to Leeuwspruit siding, when one of the trucks was derailed by a stone jammed by the Boers between the rail and guard-rail. The Boers immediately opened a heavy fire on the train, which was returned by the troops on the train, and the Boers were driven off in about a quarter of an hour.

The officers' truck was completely riddled, and many had narrow escapes.

A working party of sappers belonging to train A were engaged on reconstruction work, having left their arms and ammunition in the train. At the sound of the first volley the civilian engine-driver started the train northwards, leaving the working party defenceless, with the result that one officer and 80 men were made prisoners ; 20 of these subsequently managed to escape.

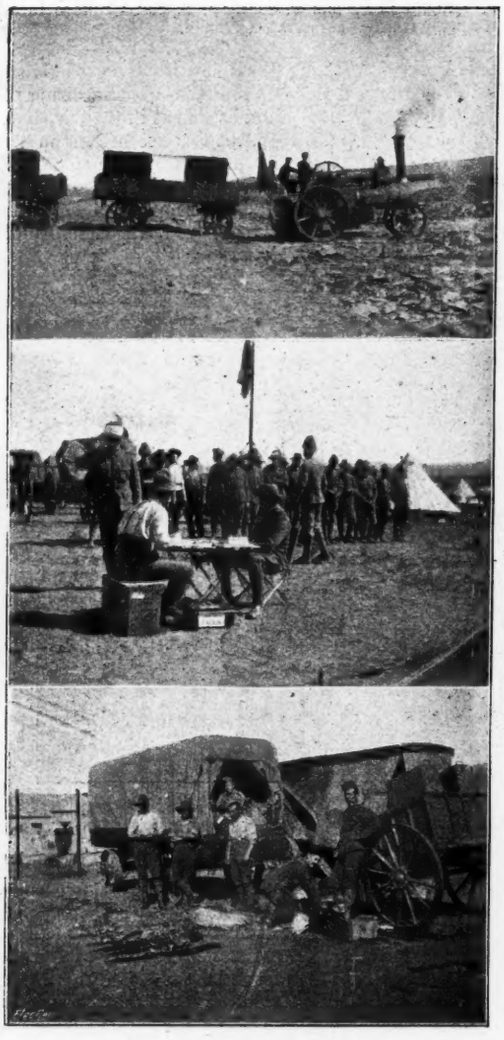
Major Crompton who was on the train, was awakened by the firing, and grasping the situation, took command ; on one of the prisoners being sent in to demand surrender, he refused to do so, and began extending his men at right angles to the train and parallel to a ridge from which the Boer firing appeared to come.

On emerging from the train, which was enfiladed by the Boers, two officers, Lieut. Micklem, R.E., and 2nd Lieut. Bigge, E.E.R.E., were wounded, and were laid in the ditch out of danger.

D

Having got his line extended, Major Crompton rushed the ridge, from which the Boers were firing, at the point of the bayonet, and took up a strong position. Later Capt. Lloyd extended another line on the other side of the train. These positions were held all night, the Boers keeping up a heavy shell fire on the train till 5 a.m., when they began to draw off. A short time afterwards a battery of artillery, sent by Lord Kitchener, came up and dispersed the remaining Boers.

The casualties in this action were one officer (Capt. Daniels, R.E.) and two men killed, two officers severely wounded



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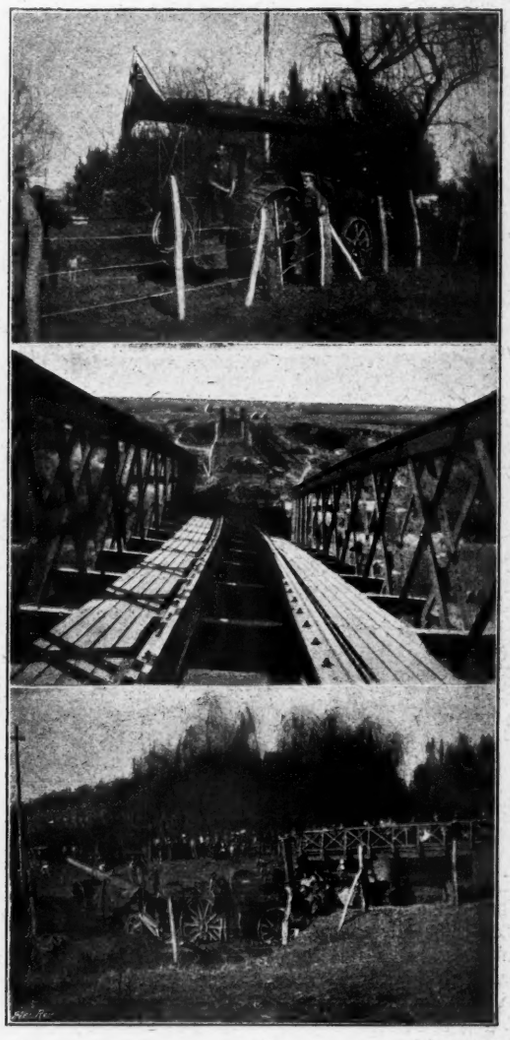


4.

5.

6.

1. Electrical engineers *en route* to Quagga Fort with water for the troops.

2. Pay-time after church parade, on Sunday, April 29th.

3. Sorting the kit of missing men after the Leeuwspruit engagement.

4. Towing 6-inch gun (shown in fig. 6) out of spruit, Sergeant Phillips sitting on tender.

5. The Zand River Bridge, as the Boers left it.

6. Steam sapper "Ursula" and a 6-inch gun of the R.G.A. stuck fast in a spruit. This gun is the largest quick-firer used in modern warfare.

ELECTRICAL ENGINEERS AT THE FRONT

engines, and have on more than one occasion gone to the assistance of transport engines in difficulties.

In one instance a 14-ton engine drawing a 6-inch 110-pounder gun, and weighing between 12 and 13 tons got stuck in a drift, the engine having broken her rope in trying to wind herself out. The engine was in right up to her axles, and the gun all over on one side. At 5.30 a.m. a working party of gunners was started, at 8 a.m. one of the Corps' engines came down. At 10.30 a.m. the small 8-ton engine belonging to the Corps, being firmly anchored to a

(Lieut. Micklem, R.E., and 2nd Lieut. Bigge, E.E.R.E.), three sappers and one civilian engine-driver wounded, and a number of Basutos killed and wounded.

From this it will be gathered that although the Corps of Electrical Engineers were not constituted as a fighting force, yet they were able to defend themselves, and were instrumental in saving the reconstruction trains, the capture of which, with their tools and repairing material, would have seriously hampered Lord Roberts's transport.

The Corps' traction engines have frequently done good service, not only for electrical work but also as emergency

tree, hove the traction engine out, and by 11 a.m. had the gun out also. Truly smart work.

Major Crompton has had orders from Lord Roberts to write a report on the subject of traction engines in war. For this purpose a board of three, consisting of Col. Hall, R.A., Major Crompton, and Capt. Lloyd, has been formed to carry out tests on the subject. These tests included the dragging of heavy guns to the summits of kopjes, the positions being fixed by Lord Roberts himself. All these tests have been carried out with remarkable ease. In one case the incline up the hill was steeper than 1 in 5 on a

ground composed of loose rubble. The gun was drawn up this by a single engine, without any necessity for using a winding drum. We gather that Major Crompton considers this result as being very favourable to the adoption of mechanical traction for this kind of work. The gun in this test weighed 12½ tons on two wheels and was over 30 feet long.

Besides these tests careful figures have been taken and records kept of the fuel and water consumed, speeds maintained, &c., both on special tracks and in the ordinary working of the engines.

The corps has lately been widely scattered, some being on telegraph work along the lines of communication, others being in Natal, the largest portion of them, however, being at Pretoria.

Among the work that has been done lately, five forts, which form the northern defences of Pretoria, have been lit electrically, and have been kept supplied with ammunition, water and materials. In some cases elaborate electrical defences have been worked out. Besides this, the hospitals round Pretoria have been lit, the erection of plant, wiring, &c., being carried out by the corps.

Latterly the equipment of engines has been increased, and the corps have been of service in taking transport to General Baden-Powell's force at Commando Nek, the engines travelling about 40 miles through an enemy's country.

From this it will be seen that the corps has been used for many purposes for which it was not intended. Its use in lighting up hospitals, forts, &c., must not be under-estimated, whilst the work of reconstruction of bridges and railways has been greatly expedited by the use of arc lamps. We gather that the telephones and cycles have been very successful, the cycles also being useful to accompany the engines on the march. There can be no doubt that the varied training of the members of the corps has enabled them to turn their hand to whatever was required of them.

Major Crompton is expected shortly to finish his good work in South Africa, to hand over the command of the corps to Capt. Lloyd, and to return home; and it is to be hoped the corps will soon follow him.

Lieut. Pott who, we regret to say, has had enteric, has just returned in the ss. *Avoca*, and gave his Chelmsford friends a look up last week. We hope that his journey home has restored him to health.

THE POULSEN TELEGRAPHONE.

The special Paris correspondent of the *Scientific American* describes this apparatus in a recent issue of that journal. He says that one of the most interesting devices exhibited at the Paris Exposition is the telegraphone invented by the Danish engineer, Valdemar Poulsen. The principle of the apparatus will be understood from the diagram, fig. 1, in

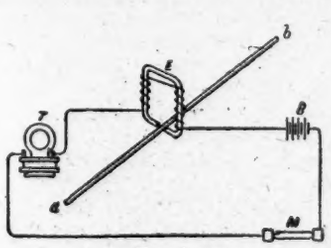


Fig. 1.

which E is an electro-magnet of small dimensions, placed in telephone circuit, including the battery, B, microphone transmitter, M, and receiver, T. The poles of the electro-magnet are very near together, with just sufficient space to allow the steel wire, *a b*, to pass; the wire may be drawn forward so as to bring its successive portions between the poles. The wire used is steel piano wire of about $\frac{1}{50}$-inch diameter, and it advances at the rate of 7 or 8 feet per second. The arrangement resembles that of an ordinary phonograph, in which the wire, *a b*, replaces the wax cylinder, and the magnetic flux between the poles, the stylus. The sound is recorded in the following manner:—When the microphone is spoken into or otherwise receives a series of impulses, the electric impulses set up in the circuit cause variations of current in the coils surrounding the electro-magnet, and in consequence the magnetic flux between the poles undergoes a series of variations corresponding to the original sound waves. These magnetic pulsations act in turn upon the steel wire as it passes along in front of the poles, and magnetise it transversely; each part of the steel wire thus preserves its part of the magnetisation, which depends upon the strength of the flux at that instant. The magnetic trace upon the wire thus corresponds exactly to the original sound waves. It remains only to reproduce the record; this is done by connecting the receiver to the terminals of the electro-magnet, and passing the wire again between the magnet poles, in the

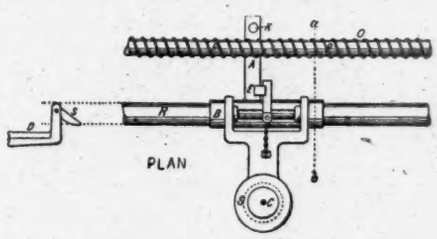


Fig. 2.

same direction as before, and at about the same speed. As its magnetisation varies from point to point, its movement between the poles causes a variation in the magnetic flux, and sets up a series of pulsating currents in the circuit, corresponding in form of wave with the preceding, and thus a sound may be heard in the telephone receiver which corresponds to the original.

M. Poulsen had constructed several different types of the telegraphone before reaching the form now shown at the Exposition. With this instrument, the sound as heard in the receiver is very distinct, and is entirely free from the disagreeable scratching noises generally heard in the phonograph. Figs. 2 and 3 show the disposition of the various parts. A drum about 15 inches long and 5 inches in

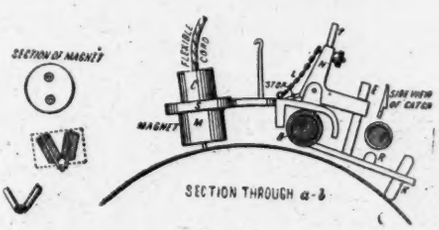


Fig. 3.

diameter revolves between two supports fixed to a metal base; at one end of the cylinder is a pulley which receives a cord passing below to the motor. In this case an electric motor is used, connected with the main lighting circuit. The drum is of brass and has a spiral groove in its surface, in which is wound a continuous layer of steel piano wire about $\frac{1}{50}$ inch in diameter; the wire makes about 380 turns. The carriage containing the electro-magnet, slides upon a rod which extends across between the brackets. The electro-magnet, shown in section in the diagram, has its cores formed of soft iron wire about $\frac{1}{25}$ inch diameter, surrounded by electro-magnets about $\frac{3}{8}$ inch long, wound with fine wire. The poles are brought near together and the ends are sharpened and slightly curved on the inner surfaces so as to partly embrace the wire. The coils are surrounded by insulating material, which consolidates the whole. The magnet, M, is held above the wire upon a support, S, and into it is fitted a contact piece, C, carrying a flexible core for the current. To guide the magnet along the wire by the points alone, might injure these, as they are somewhat delicate, and accordingly a guiding arrangement has been provided, which consists of a steel knife edge, K, fixed to an arm in the rear; the arm is fixed to a brass

service, not only for electrical work but also as emergency

case the incline up the hill was steeper than 1 in 5 on a

sleeve, B, which slides upon the main rod. In this way the carriage, which rests also upon the sleeve, is guided by the knife-edge. The arrangement devised by Poulsen to bring back the carriage to the starting point is simple and ingenious. As the cylinder turns, the carriage is thus guided to the end of its course; at this point is fixed an inclined plate, S, carried on an arm, seen also to the left of the illustration. The projecting piece, T, of the lever, H, strikes the plate, and the magnet carriage is tilted back in the direction of the arrow; the lever then engages with a catch, E. It will be seen that if the carriage is now moved to the right, the rear arm, A, will be lifted by the weight of the carriage around R as a centre; this causes the button, R, to engage with a wire, P, which is wound spirally around the rod, O, and as this rod is revolved by a pulley the carriage is brought back to its starting point. The chain, shown at L, serves to hold the magnet off the wire when not in use.

In order to reproduce conversations with the utmost distinctness, the wire-wound drum must be rather rapidly rotated. Experience has shown that a velocity of 1·64 feet (0·5 m.) per second gives the best results. A conversation of one minute in duration could, therefore, be recorded on 98·4 feet (30 m.) of wire, which is approximately the capacity of one pattern of the instrument. But, for the ordinary requirements of life, this time is far too short. Longer conversations are recorded and reproduced by means of the apparatus shown in fig. 4, in which a very thin flat

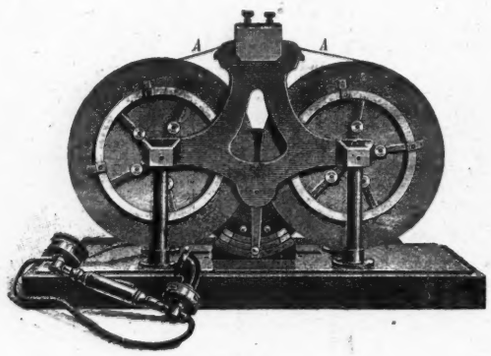


Fig. 4

steel ribbon, resembling a telegraph tape, takes the place of the wire. The ribbon, A, passes from one roll over a standard mounted in the middle of the apparatus to a second receiving roll. Upon the standard the electro-magnet—not shown in the illustration—is mounted, the two poles of which are arranged transversely to the ribbon. The principle is the same as that of the instrument previously described. Although the layers of the ribbon are tightly rolled in a coil, the magnetism of one layer exerts no influence whatever upon the magnetism of the adjacent layers.

A conversation once magnetically recorded can be repeated indefinitely. Experiments which have been made show that a conversation can be reproduced from one to two thousand times without any perceptible diminution in clearness.

To efface the record, it is only necessary to pass a current from a few cells of battery in the circuit of the electro-magnet, when the magnetisation of the wire is equalised and it is ready to receive another record. Poulsen recently presented an account of the telegraphone to the Académie des Sciences, in which he explained its principles. He also noted an interesting experiment which has been made by his assistant, M. Pederson, who has charge of the instrument at the Exposition; this is the registering and reproducing of two separate conversations on the same wire. Two electro-magnets are used, whose windings are combined so that each is insensible to the record produced by the other. The first electro-magnet has its windings connected in series, and the second in opposition; under these conditions the records produced by the two magnets may be superposed and separated at will. The superposition of the two magnetic curves has the effect of a resultant in each point of the steel wire, but as one of these components is always neutralised by one or the other of the receiving magnets, it is seen that by using one or the other set of magnets, the first or second series of components may be received, that is to say, the first or second conversation.

The telegraphone is already in practical operation in several telephone stations in Denmark, and by its use telephone messages may be received and kept indefinitely. A subscriber may thus receive messages which have been sent in his absence.

LIQUID AIR AND THE COMPANY PROMOTER.

The type-printed circular which accompanies the prospectus of the "Liquid Air, Power, and Automobile Company, Limited, of Boston" (U.S.A.), points to a recrudescence of company promoting endeavour.

It is headed "Private and confidential," underlined. This, however, is not original. We have seen these words used before in connection with prospectuses sent broadcast throughout the land.

Although this circular is issued by the Foreign Syndicate, Limited, of Moorgate Station Chambers, London, E.C., its contents smack of a Yankee origin. For instance, the circular assures intending "stockholders" that "the fortunate ones who secure this stock on the terms now offered will see the future value of their holdings exceed even their greatest expectations."

Again, liquid air — according to the circular — is "stronger than dynamite, and one hundred times more powerful than steam."

The prospectus of the Liquid Air, Power and Automobile Company, of Boston, is replete with similar gems of thought. Thus:—"When it is considered that power is indispensable to every movement upon the earth; that the cost of such power is a heavy tax upon every branch of manufacture and transportation, and that *liquid air, while giving far greater effectiveness than other powers, will vastly reduce this tax*, it may readily be seen how limitless is the field open to the controllers of this greatest of all nature's forces."

It is interesting to consider what is involved in the last three lines:—

1. That the promoters understand what they mean by liquid air "giving far greater effectiveness than other powers"—no basis of comparison being suggested.
2. That it (liquid air) will vastly reduce a tax; what tax, and how it is to be reduced is not stated.
3. That there are degrees of "limitlessness."
4. That the promoters have marshalled *all* of nature's forces, and after having tested them have found that liquid air is the greatest.

Now, liquid air is not a force of nature. This, moreover, appears to be dimly recognised by the promoters, as a little further down the same page we find that, "approximately speaking, 1 lb. of coal is required to make 1 lb. of liquid air."

The promoters reply to their own question, "What is liquid air?" is worth quoting. We are told that this question has been frequently asked, but, in the belief of the promoters, has rarely, if ever, been answered in a way intelligible to any but a scientist. We therefore with reason look forward to an intellectual treat in the explanation which the promoters give us in their answer to this question. It is as follows:—

"It (liquid air) is simply the atmosphere we breathe,

the wire, *a b*, replaces the wax cylinder, and the magnetic

fixed to an arm in the rear; the arm is fixed to a brass

compressed in a series of cylinders, each successive cylinder pressing the air into a smaller and smaller space, the air after each pressure passing through cooling tanks, until finally when squeezed into about $\frac{1}{800}$th of its original compass, and cooled to 312° below zero, it changes from a gaseous state to a liquid."

After so clear an explanation everyone will know just exactly what liquid air really is, and those of us who were sceptical upon the matter will be able to assert without fear of contradiction, even by scientists, that liquid air, is air liquefied.

Among other wonderful things possessed by the company is a "most ingenious yet simple contrivance, the Power Transmitter," whereby it is made possible to produce "5-H.P. leverage from 2 H.P. without additional cost," and yet the promoters have "no mystery of the spheres, no secret processes," in connection with the enterprise.

With reference to profits, the following modest estimates are made :—

"The profits from such a monopoly may possibly be estimated, but even those of the greatest corporate successes of the day cannot begin to compare with them."

Again :—"We hold the key to millions in profits, and we confidently affirm that no other undertaking in the world's history ever produced such enormous returns as will this company, the first to make liquid air a controllable power."

After these moderate expressions of opinion, we may for a moment consider the degree to which they may be said to be consistent with the technical aspect of the matter.

The processes by which liquid air is produced may be said to be of a special character, and the apparatus by which ordinary atmospheric air that one breathes is squeezed into $\frac{1}{800}$th part of its original compass, and is incidentally cooled to 312° F. below zero, cannot justly be likened in simplicity to that used in butter-making. Then, when air has been liquefied, it cannot be put into a barrel and drawn off as required by some such device as a beer engine. Again, in order that its "effectiveness" may not be impaired, it is essential that the temperature necessary to preserve the liquid state be preserved. If this temperature rise sufficiently, the liquid air will boil, and at the ordinary temperature of our atmosphere, will exert an enormous pressure upon the walls of the containing vessel. Liquid air, therefore, must be stored in some receptacle which is kept at a suitably low temperature, unless the vessels in which the liquid air is to be distributed are made to withstand an enormous internal pressure. Now, it is a fundamental commercial principle that any goods intended to be introduced successfully on the world's markets must be capable of being stored under ordinary conditions without suffering any serious deterioration. The very nature, therefore, of liquid air is an extremely serious obstacle to its commercial development.

It is clear that the most that liquid air can do is to expand to its original volume, hence the work done upon a certain volume of air in order to liquefy it is the limit of its capacity to do work, even if the cycle of operations is reversible at an efficiency of 100 per cent. It must be obvious, however, that the heat abstracted in cooling after compression cannot be reconverted into work, and that the friction of compressors working under such pressures as are necessary for the liquefaction of air will be a considerable amount.

Assuming, for ease of calculation, that the figures given in the prospectus are substantially correct, it would appear that about $5\frac{1}{2}$ H.P.-hours, represent roughly the work-equivalent stored in a cubic foot of liquid air, but in the prospectus it is stated a cubic foot of liquid air would develop "$5\frac{1}{2}$ H.P. per hour" (presumably $5\frac{1}{2}$ H.P.-hours is meant). It is difficult to see how this could be realised in practice, for reasons which will be sufficiently obvious to engineers.

That liquid air may, in certain special circumstances, be invaluable, is not to be doubted, but a point which is overlooked in the prospectus is the practical difficulty that would be met with in the use of highly compressed air, namely, the lowering of the temperature due to expansion in doing work.

We may fittingly conclude by quoting a portion of one of the paragraphs in the prospectus :—

"It seems almost incredible that such enormous power as will within a few years, if not months, supersede in many ways steam, electricity, compressed air, gasolene, and all other powers now in use, can be secured from the earth's atmosphere at a nominal cost."

The idea of squeezing anything to $\frac{1}{800}$th of its original volume, cooling it to — 312° F. at a nominal cost, and distributing it commercially, is, we quite concur, almost incredible. Further, we must not forget what the promoters themselves state, namely, that no one can claim a monopoly of liquid air, and that only the means of producing and distributing it can be patented. The promoters only claim to possess the best means of doing this, and while this may be true at the moment no one can say whether or not the promoters will find their present position tenable in the near future.

THE NERNST LAMP.

The pavilion of the Allgemeine Elektricitäts Gesellschaft at the Paris Exhibition is lighted by 800 Nernst lamps scattered over the surface of the dome. The pure white light of the lamps illuminates the whole interior of the building with the brightness of daylight, and shows up the frescos on the walls in their true colours.

Since it is now nearly two years ago since this lamp was brought before the public at the Society of Arts by Mr. Swinburne, it is evident that the practical difficulties to be overcome before it could be put on the market must have been considerable.

As our readers are aware, the source of light in the Nernst lamp is a filament made up of a mixture of the rare earths such as is used in the Welsbach incandescent gas mantle. At the ordinary temperatures this filament is a non-conductor for electric pressures such as are available in public supply, but when the filament is heated by a match or a spirit flame the current passes through it and renders it brilliantly incandescent. Since the conductivity of the filament continues to increase as the temperature rises, some device for checking the current at a safe limit must be added to the lamp. This is effected by connecting in series with the filament a piece of iron wire, the resistance of which increases with the temperature. Lamps have often to be

Fig. 1.

fixed in places which are inaccessible to the lamplighter. For such cases an automatic lamp has been devised, in which the preliminary heating of the filament is done by a coil of platinum wire placed near it and thrown automatically out of circuit when the lamp is lighted.

The latest forms of the lamp are shown in fig. 1, the globes being removed to show the construction of the lamps.

On the left is the ordinary form, which requires to be

heated by a match or a spirit flame before it lights up; on the right may be seen the automatic lamp. The ordinary lamp is quite simple in its construction. From the porcelain base rise two metal rods, joined at the top by a cross piece of porcelain, which serves as a brace. To the ends of the rods are soldered the wires which support the filament, this being quite short and of horse-shoe form. Between the rods will be noticed a small glass bulb which contains the supplementary resistance. This is a fine iron wire placed in series with the filament; its resistance rising with the increase of current compensates for the decrease in resistance of the filament when incandescent. The wire is wound on a porcelain tube and placed in a small glass tube as shown, being connected directly in series with the filament. To light this lamp all that is necessary is to heat the filament with a match or an alcohol flame for a few seconds, when the filament is seen to redden at first, then becomes incandescent with a brilliant white light. The globe seen on the left is made with a metal base to fit in the socket, and it can be removed at will; it is open at the outer end.

The automatic form of lamp is entirely self-acting. From the porcelain base, which is hollow, rise three rods, passing through the lower porcelain disc and supporting an upper disc of the same substance. Through the upper disc pass the ends of the rods, and to these are fixed the horizontal filament and the heating spiral which surrounds it. The spiral is of porcelain, which before being baked is surrounded with a great number of turns of fine platinum wire, which becomes imbedded in the porcelain during the baking, and is thus firmly held, with the upper side only visible. Upon passing the current, the platinum wire heats up, and soon raises the temperature of the filament, which is placed in the interior, sufficiently to allow the passage of the current in the latter. When the filament becomes incandescent, the current increases sufficiently to operate a magnetic cut-out placed in the base of the lamp, underneath the lower disc. The cut-out breaks the current of the heating spiral, which is parallel with the filament.

The arrangement of the circuits of the automatic lamp is shown diagrammatically in fig. 2. To one end of the refractory filament A, A, is connected the compensating iron wire resistance R; to the other end, one terminal of the coil

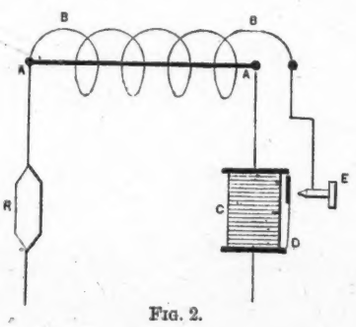


Fig. 2.

of the electro-magnet C. The heating spiral B, B, is connected at one end to the filament A, A, and at the other end to the stop. When the filament is cold no current passes through the magnet coil C, and the spring-supported armature rests against the stop E. Thus, when the current is first turned on to a cold lamp, it passes first through the armature D, the stop E, the heating spiral B, B, and the resistance R. When the filament has been sufficiently heated by the spiral B, B, part of the current passes through the coil C, and the filament; finally pulling away the armature from the stop E, and breaking the circuit of the spiral B, B.

M. Bussman, who has been engaged in perfecting this lamp in the factory of the Allgemeine Elektricitäts Gesellschaft, says the price of the automatic lamp is naturally higher than the other, owing to the electro-magnet and the heater, of which the former is practically indestructible, while the latter lasts a certain time, and is then taken back for two-thirds its original value. It is probable that the platinum wire will soon be replaced by a wire made of a less expensive metal. As to the life of the Nernst lamp, it may be averaged at 300 hours; the filament deteriorates by a molecular change which takes place little by little, this being accompanied by a diminution of solidity and often an increase of resistance which lessens its brightness. The expenditure of energy is from $1\frac{1}{2}$ to $1\frac{3}{4}$ watts per candle. The lamp is now made in 25, 50 and 100 C.P. for voltages of 110 and 220. At present, experiments are being made to produce a high candle-power lamp to replace arc lamps. It is not considered that the Nernst lamp will entirely replace the ordinary glow lamp. The new method of lighting, it is hoped, will regain a part of the ground lost to the Welsbach burner. For most of the above particulars we are indebted to our contemporary the *Electrical Review*, New York.

If the average life of a Nernst lamp is only 300 hours, it does not appear likely to soon replace the ordinary carbon filament lamp. The Nernst filament is of the same or similar composition as the Welsbach mantle, and it seems to have the same faults. It may start with a lighting efficiency double that of the carbon filament, but how long will it maintain this efficiency? The trouble and worry of replacing filaments and heating coils at comparatively short intervals would damp the enthusiasm of the average householder for the new lamp. The pure white light emitted by the lamp may make it suitable for certain special cases; or if the lamp can be made powerful enough to replace the arc lamp, there will be a considerable sphere of usefulness open to it.

THE BURGDORF-THUN POLYPHASE ELECTRIC RAILWAY.

Translated from the Danish paper *Ingeniören* by J. Lehmann and W. Park. The original article was written by Will. Rung, E.E., of the firm of Brown, Boveri & Co.

The opening of a full-gauge polyphase electric railway in Switzerland on July 21st, 1899, was a most important event in the history of electric traction.

The railway, which is about 25 miles long, connects the towns of Burgdorf and Thun, and is of particular interest as being the first full-gauge line operated by three-phase alternating current.

The application of polyphase currents to traction was in the first place due to Mr. C. E. L. Brown, of the firm of Brown, Boveri & Co., who designed the three-phase electric tramways of Lugano, opened in July, 1896.

The system proved so satisfactory that it has since been employed by the same firm for the working of several mountain railways, among which may be mentioned the Stansstadt-Engelberg line, the Gornergrat line, and also the Jungfrau line, which is still under construction. The new railway between Burgdorf and Thun has proved the system to be equally suited for ordinary traffic on full-gauge lines.

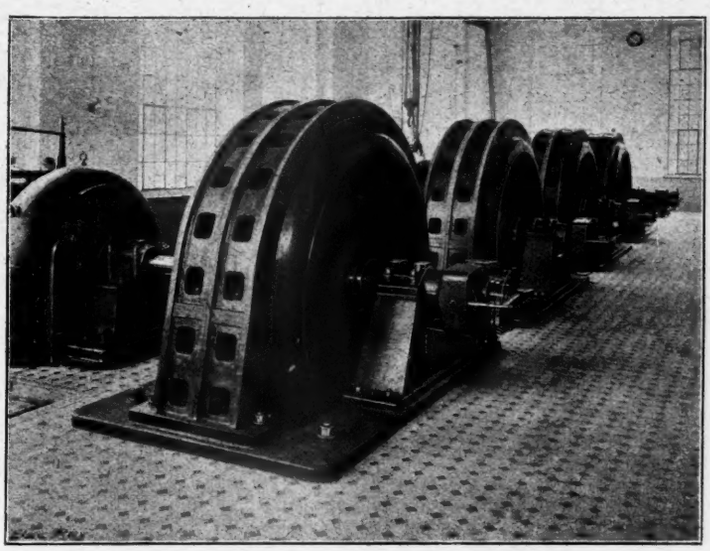
In considering whether direct current or three-phase alternating current is preferable for railway working, each of the systems will, of course, be seen to possess its advantages and disadvantages, but the latter system will doubtless prove the more satisfactory where the line is of considerable extent. The first, and perhaps the most important, objection which can be urged against the three-phase system is the necessity of having two overhead conductors. This disadvantage, however, is not so great as might at first be supposed.

The unsightly appearance of the overhead wires is mainly due to the numerous poles with their arms and suspension wires, and not to the presence of the additional conductor; so that the same complaint might be made against the single overhead trolley system. Also, the two wires are much thinner than the single wire would require to be, the weight of copper in the two wires together only slightly exceeding that of the single direct-current wire.

One great advantage of using alternating current is that the rails may be utilised as part of the circuit without the prejudicial electrolytic action noticeable in the case of direct currents. The presence of the two overhead wires does not produce the complications at crossings one might imagine. One of the wires is interrupted at such places, and the current taken from the other only, the three-phase motor being,

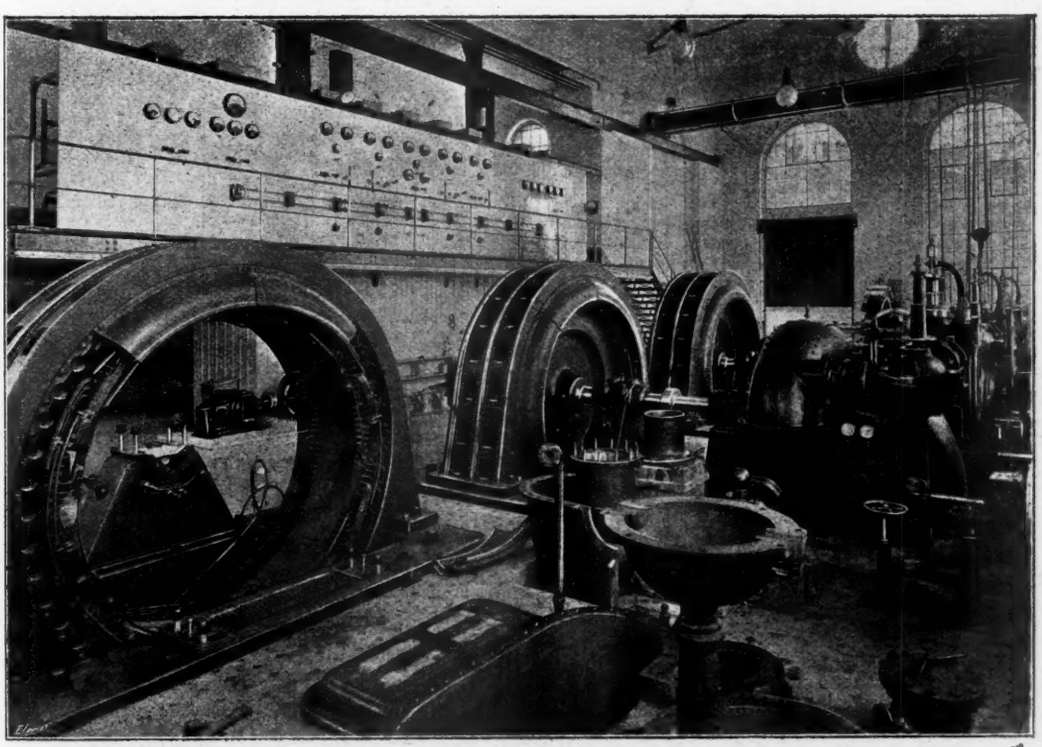
as is well known, able to run as a single-phase motor when first started, a circumstance of importance also, if by chance one of the two trolleys should leave its wire; as long as the other remains in contact the motors are still under full control of the driver, and by properly placing the points of support, it is practically impossible for both trolleys to leave the wires at the same time. In this way, also, detrimental sparking is almost wholly avoided, and when sparking does occur with alternating currents it is much less serious than with direct currents, so that the overhead wires have a longer life.

The main advantages of alternating current for railway working are the following: — With a small cost of leads and an inconsiderable drop of voltage, it is possible to supply current to a very extended network of lines. As the alternating current can be transformed with insignificant loss, and the transformers require no attention, the current may be generated at any desired high pressure and supplied to various points on the line, and there transformed down to the working pressure. In this way not only are heavy feeders rendered unnecessary, but even the contact wires may be reduced in diameter. Against this it might be urged that the same thing could be done with continuous current, either by using a high tension current directly, or an alternating current, which at the feeding points of the line is converted into direct current at the desired pressure. But this method involves complicated machinery, which is not only costly but requires the constant services of skilled attendants. Nevertheless, the system has been used in many cases in America and in this country.



Three-phase Alternators in the Kander Power Station.

As to the motors, experience shows that a three-phase motor, owing to its more simple design, is less liable to get out of order than a direct current motor. A very important advantage of the alternating current motor is the absence of a commutator. Also its starting torque is at least as large as that of a direct current motor, generally larger, because the former at full load works at a lower induction than the



Generator in Course of Erection in the Power Station.

latter, and so is able to produce for a short time power far exceeding the normal. As is well known, the current is led into the fixed part of the motor—the stator, so inducing in the rotor another alternating current of a different voltage depending on the windings of the motor; by varying the resistance of the armature circuit, the speed can be controlled, and when the rotor pressure is kept low the resistance can be of simple design.

If the resistance is short-circuited the motor runs at maximum speed, and maintains this speed with varying load, enabling the cars to run at a fixed speed, whether up-hill or down-hill. Thus, no regulation is needed, and the control of the cars is rendered very simple. When going down hill the motor acts as a generator, sending current back to the leads, and so automatically brakes itself, and prevents the speed from exceeding a certain maximum value. This is, of course, a matter of enormous importance, especially in the case of mountain lines. After having started the car and brought it up to its normal speed, the driver has nothing more to do with controlling it. The car itself keeps up its normal speed, and the driver never has to fear any exceeding of that prescribed speed.

The new railway from Burgdorf to Thun, of which a description is now given, has satisfied all requirements, and although it mainly serves the local traffic, it is, on account of its connections with several main lines—for instance, those between Zurich, Berne, and Geneva—to be considered a valuable intermediate link of the through service, forming a direct junction between North and East Switzerland and Bernese Oberland.

The principal reason that it was decided to adopt electric traction was the cheapness of working made possible in this way. The line having numerous curves and gradients, and five trains being supposed to run in each direction a day, it was found that the annual expense for fuel only would be some £2,100, if steam locomotives were used; whereas, by adopting electric traction, it would be possible, with the same expense, to send 10 trains in each direction per day, as well as two goods trains.

The cost of the entire construction of the line, fully equipped, amounted to about £212,000, of which the electric installation came to £30,800.

Some particulars of the line itself are stated below:—

Gauge = 4 feet 8½ inches.	
Length of line = 25 miles.	
Length of tracks = 31·6 miles.	
Number of sidings = 69.	
Number of stations = 15.	
Longest distance between stations	= 2·65 miles.
Shortest " " "	= 0·76 mile.
Proportion of curves to total length	= 36 per cent.
Curves from 270—540 yards radius	= 29 per cent.
" 540—1,080 "	= 4·85 "
Curves more than 1,080 "	= 2·15 "
Steepest gradient	= 1 in 40.

Vignoles rails are used, in lengths of about 40 feet, and weigh 72 lbs. per yard.

The system of working is mainly as follows:—The current from the power house passes through three wires along the permanent way, at a pressure of 16,000 volts, and by means of 14 transformers in parallel at various points on the line the pressure is reduced to 750 volts. This current is supplied to the overhead conductors, consisting of two copper wires 8 millimetres in diameter, the rails being used as the third lead. The motors derive their current from the overhead wires by means of two special contacts, and from the rails through the wheels of the car.

We shall now consider more fully the various electric arrangements.

The Power House.—The generators are driven by turbines, and power is obtained by carrying off a part of the River Kander, which empties itself into the Lake of Thun, in the neighbourhood of Spiez. The water is conducted in heavy wrought-iron pipes to the turbine house at Spiez. The amount of water varies from 880 to 1,540 gallons a second, and the total fall amounts to 206 feet. In the turbine house there are six turbines (including spare ones) representing a total power of 900 H.P. These were built by Messrs. Escher, Wyss & Co., Zurich, and are of the horizontal type, each of them being directly coupled to a three-phase generator. Each alternator has a separate exciter directly coupled to it, and the exciters are themselves excited by one of two small direct current dynamos driven by two separate turbines, the other one being usually run for lighting the power house only. This arrangement affords a very easy and handy regulation of the voltage, the small turbines being provided with specially precise regulating devices. The alternating current from the generators has a terminal pressure of 4,000 volts and a frequency of 40 periods per second. Some of this is supplied directly to a few villages in the vicinity, but the greater part is transformed up to 16,000 volts, and conveyed at this pressure to the towns of Berne and Burgdorf, and there used for the railway and for other purposes. The whole of the electric plant was supplied by the firm of Brown, Boveri & Co., of Baden.

(To be continued.)

CORRESPONDENCE.

Proposal to form an Electrical Contractors' Association.

I have noticed in your paper letters written by electrical contractors complaining how they are bullied by both the consulting engineer and manufacturers. As a member of a firm in which electric lighting is an important branch, and at the same time the least satisfactory, the electric wiring contractor seems, as far as our experience goes, not to be able to hold his own as in other branches of my firm, where, if the manufacturer is found selling direct, his account is closed as far as we are concerned, and his name is brought before that particular local association, and eventually handed to other branches in different parts of the country to be mentioned to their members, and pressure brought to bear on the manufacturer, either by protest or boycotting them as far as possible. I think if an association could be formed on similar lines to either the Ironmongers or Plumbers, it might help to raise the electric light contractors to a more satisfactory business footing, and also stop the present cutting of prices. At present, anybody hangs up a sign as electric light contractor, whether he keeps a sweet shop or sells tobacco, and seems to be able to get any amount of credit from the electrical manufacturer. I should be pleased to further any association of this sort, as far as myself or my firm could do, and should be glad if you would see your way to publish this letter, inviting correspondence from other electric lighting contractors, and your paper to take up the initial stages of the association.

Rowland E. Dixon.

October 4th, 1900.

Gas v. Electric Driving.

Your correspondent "Inquirer," in issue of 5th inst., gives neither price of gas nor of electric current, but the following are fair assumptions and may be useful for comparison:—

Consumption strictly according to load controlled by governor.

	Per hour.
COAL GAS:—	
High class gas engine will give 75 B.H.P. for 1,200 cubic feet of gas per hour.	
Cost at 2s. 6d. per 1,000 cubic feet	3s. 0d.
(No continuous attention required.)	
PRODUCER GAS:—	
Similar engine (slightly larger) will give 75 B.H.P. for 1½ lbs. of anthracite per H.P.-hour = 1 cwt.	
Cost at 15s. per ton	9d.
Cost of attendance	8d.
Total	1s. 5d.
ELECTRIC CURRENT:—	
Motor will give 75 B.H.P. for 75 units per hour.	
Cost at 2d. per unit	12s. 6d.

W.

[While we insert this letter, we must enter a protest against the unfair comparisons made therein. For example, the efficiency of the motor is taken as low as 75 per cent.—an absurd value; and the marginal note is far more applicable to the motor than to the gas engine.—EDS. ELEC. REV.]

The Limitations of Block Signalling.

It would go a long way towards answering *the* question which is asked in the article on the above subject in your last issue, if some impartial observer with the requisite information at his disposal, could say what the respective averages are, in the matter of accidents, for railways worked on the "lock and block," and for railways worked by block telegraph only.

There would appear to be a tendency on the part of those who write about block signalling to assume that fallibility is necessarily human. But if a signalman is liable, through pre-occupation or absent-mindedness, to break rules, it is only right to point out that the "lock and block" has its fits of abstraction also.

The rail contact may tell an untruth to its *confrère*, the signalman, who is relying upon it, and the electric lock may be released by a current which was never intended for it.

It would be interesting to know which of the two, the man or the electrical appliance, holds the worst record for breaking rules.

C. M. J.

Interior Wiring.

In reply to Mr. Fennell's letter of last week, I may say that I remember an occasion on which the voltage on the Leyton mains rose considerably, so that a number of lamps were burned out, but I certainly never heard the explanation which Mr. Fennell now gives, and I cannot see that this explanation accounts for the phenomenon. Firstly, how should *intermittent* earthing of the mains cause a "persistent" short? Secondly, in any properly-designed three-wire system it is impossible, even if one side be shorted, for the voltage on the other side to rise to such an extent that the lamps are burnt out. If I remember rightly, the only explanation we could think of at the time for the rise of voltage at Leyton was that the neutral conductor was accidentally disconnected from the switchboard.

Mr. Fennell thinks he has proved that intermittent earthing of the mains is impracticable; his arguments apply with still greater force against permanent earthing of the middle wire, yet this is the usual practice, both in this country and in America, and is therefore certainly not "impracticable."

It is true that the object of the intermittent earthing is not to burn out faults on the mains, but only to blow the main fuse of any consumer who may have an earth on his wiring. The earth connection may be made through a low resistance, capable of passing sufficient current to blow any consumer's main fuse, or it may be made through an automatic cut-out or a heavy fuse. The current needed to blow the main fuse, even of a large consumer, would be small compared with the total output of the station, and would not seriously affect the voltage on the mains.

It seems that Mr. Fennell objects to my writing in the first person singular. Does he think that, because I was at one time in partnership with him, I should never write except in the first person plural? He apparently wants to take credit for the substance of my article, and yet he does not agree with it!

G. C. Allingham.

Prof. Thompson's Lecture at Bradford.

You have admitted that your editorial article of September 21st misrepresented me, and you have explained that the misrepresentation was unintentional. I accept the more readily your explanation, because it takes the point out of the ugly inuendo in the last two lines of the article on page 447. You have done everything that could be expected of gentlemen in your position, except to apologise to the person whom you have unintentionally misrepresented. Perhaps you intended to apologise. Perhaps, also, that inuendo was unintentionally thrown in. I am willing—strange as it may seem—to believe so. It would not be intentionally put there by gentlemen in your position. If you assure me so I will say no more.

Silvanus P. Thompson.

[We fail to see the inuendo of which Prof. Thompson complains, but if it is there it was quite unintentionally thrown in. Surely we have now said enough to satisfy even a gentleman in Prof. Thompson's position.—Eds. Elec. Rev.]

Information Wanted.

Could you, or any of your readers, give me instances of the present use of wind power for electricity generation?

P.

PRACTICAL CONSIDERATIONS INVOLVED IN THE GENERATION OF POWER BY BLAST FURNACE GAS.

(*Continued from page* 504.)

It has been stated that each ton of coke consumed in the blast furnace for smelting the iron requires 4·47 tons of air for its combustion; it may be as well to confirm this roughly.

Assuming that the coke contains 90 per cent. of carbon, this is equal to 2,016 lbs. of carbon.

The pig-iron produced by this coke will contain 4 per cent. of carbon = 89·6 lbs. of carbon, 2,016 − 89·6 = 1,926·4 lbs. of carbon.

The amount of air necessary to supply the oxygen for the combustion of this carbon to carbonic oxide will be given by the following formula:—

$$\begin{array}{ccc} C & + O & = CO \\ 12 & + 16 & = 28 \end{array}$$

which shows that 1,926·4 lbs. of carbon will require 2,568·5 lbs. of oxygen.

A certain proportion of the carbon is converted to carbonic acid gas, but the oxygen for this is derived from the oxide of iron in the ore.

2,568·5 lbs. of oxygen derived from atmospheric air would be associated with nitrogen in the proportion—oxygen 22, nitrogen 77, so that 2,568·5 lbs. of oxygen would be accompanied by 8,989·7 lbs. of nitrogen.

2,568·5 O + 8,989·7 N = 11,558 lbs. of air = 5·1 tons, which, without going deeper into the chemical changes occurring in the blast furnace, approximately confirms the proportion of air blast necessary for the consumption of one ton of coke in smelting iron ore.

In only a few furnaces at the present time is the air blast employed at atmospheric temperature, the product of the furnaces in these cases being what is called *cold blast* iron. More generally the air is heated, either in pipe stoves or fire-brick stoves.

With cast-iron pipe stoves the temperature of the blast delivered to the furnace does not often exceed about 900° F.

When fire-brick stoves are employed the temperature is higher, say, from 1,200° to 1,400° F.

It will be convenient to consider that the temperature of the blast is in most cases raised 1,000° F. above the temperature of the atmosphere.

On the introduction of hot blast, coal was employed for raising the temperature of the air, but as a natural consequence the "waste" gases attracted attention, and comparatively crude arrangements were made for diverting a sufficient quantity of the gas for the purposes of heating the stoves and providing the steam necessary for driving the blowing engines, and the power required for hoisting the charge to the top of the furnace, as well as pumping the water for tuyere cooling purposes.

The method of collecting the waste gases has been referred to as crude, because, until recently, no attempt was made to recover the whole of the evolved gases by the most perfect arrangement that could be devised, but only to recover sufficient gas for the purpose immediately required.

If we assume that the specific heat of air remains constant at ·2374 at all temperatures, and suppose the temperature to be raised 1,000° F., the amount of heat required to be supplied can be calculated:—

Air required per hour = 4·47 tons ×
2·678 × 2,240 ... ... = 26,813 lbs.
26,813 lbs. × ·2374 × 1,000° ... ... = 6,365,406 B.Th.U.

To supply this amount of heat by burning gas having a composition such as we have taken for the purposes of this

E

article, with a minimum amount of air, and with the products of combustion of the stove leaving at 700° F., the following calculation will give the approximate volume of gas in cubic feet, when measured at 60° F., and 30 inches barometer, required to be burned in the stove.

Heat developed in B.Th.U's, per cubic foot of gas at 60° F., and 30 inches barometer:—

CO	·25 × 319 = 79·75	B.Th.U.
CH_4	·02 × 908 = 18·16	„
H	·01 × 282 = 2·82	„
Total per cubic foot ...	100·73	

The quantity of heat carried off by the products of combustion for each degree of temperature can be estimated:—

CO_2	·12 × ·0252	= ·003
CO	·25 × ·0614 (·0252 + 2 × ·0181)	= ·015
CH_4	·02 × ·2152 (·0252 + 2 × ·0226 + 8 × ·0181)	= ·004
H	·01 × ·0588 (·0226 + 2 × ·0181)	—
N	·60 × ·0181	= ·011
Total heat carried off for each degree of temperature		= ·033

As the temperature of the products of combustion in the stove is taken as 700° F., we have

$$700 \times \cdot033 = 23\cdot1 \text{ B.Th.U.}$$

Heat developed per cubic foot of gas	100·73	B.Th.U.
„ carried off „ „ „	23·1	„
Theoretical amount of heat available for heating the air blast per cubic foot of gas consumed	77·6	„
6,365,406 ÷ 77·6 = 82,041 cubic feet of gas per hour theoretically required in the stoves. Radiation and other losses would be covered by an addition of 25 per cent. to this, bringing the volume of gas required to be reserved for heating the blast to 82,041 + 25 per cent. ...	102,550	cubic feet.
Total volume of gas evolved per hour	455,260	„
To supply the heat of the air blast (rather more than a quarter of the total volume)...	102,550	
If we allow 20 per cent. of total to cover unavoidable waste = ...	91,052	
Available for utilisation in development of power	193,602	„

193,602 cubic feet of gas per hour at 100 B.Th.U. = 19,360,200 B.Th.U. One H.P.-hour is equivalent $\frac{33{,}000 \times 60}{778} = 2{,}545$ B.Th.U.; therefore, the above quantity of gas is theoretically capable of developing ... 7,607 H.P.

The gas engine is capable of turning 28 per cent. of the heat into available power, giving ... ... 2,130 H.P.

The consumption of gas per effective horse-power-hour being little more than 91 cubic feet.

The average thermal value of the coke (C = 90 per cent.) charged into the furnace for smelting the iron ores may be taken at 12,000 B.Th.U. per lb.

$$2\cdot678 \times 2{,}240 \times 12{,}000 = 71{,}984{,}640 \text{ B.Th.U. 100 per cent.}$$

Sensible heat of the gases, 455,260 cubic feet × specific heat ·0191 × 500° F. = 4,347,733	6·0 per cent.
Heat of combustion of the gases, 455,260 cubic feet × 100·73 B.Th.U. = 45,858,340 ...	63·7 „
Total heat required for the smelting of the iron ore, including that carried out by the molten iron and slag, the water used for cooling purposes, and loss by radiation, 21,778,567...	30·3 „
	100·0

The sensible heat is not all lost when the gases are burned in firebrick or other stoves, if the conducting tubes and flues are brick lined, but assists in the ignition of the gas.

When the gases are employed for raising steam by means of boilers the sensible heat is an advantage, but the variations in the pressure and the impossibility of regulating the air supply to meet these variations, as well as the effect of the dust deposited upon the heating surfaces in reducing the rate of conduction, all go to reduce the efficiency of the gases when employed in this manner much below that obtained by its employment in a gas engine.

(To be continued.)

THE SYNCHRONISATION OF ALTERNATORS COUPLED IN PARALLEL.

[Condensed translation of the second and third parts of a paper entitled "A Study of the Transmission and Distribution of Energy by Alternating Currents," read before the Société Internationale des Electriciens by M. Maurice Leblanc.]

(*Continued from page 544.*)

Services that an Induction Motor is able to Render when Employed as a Generator.

Let A B and C D be a line of two conductors, arranged to distribute single-phase alternating currents, furnished by any source of alternating E.M.F. M, N an induction machine such as the preceding, and X, say, a lamp circuit taking the current i (fig. 7).

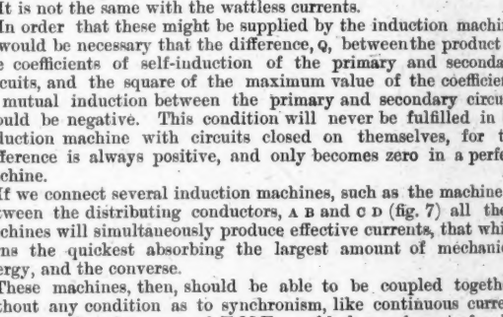


Fig. 7.

Suppose that the source of E.M.F. M maintains an alternating difference of potentials of constant effective value between the conductors A B and C D.

The author of the paper works out an expression for the strength of the current J taken from the source M, consisting of two terms, one involving principally resistance, the other principally self-induction.

The first term of this expression represents the effective current, and the second, the wattless current, which must be furnished by the source of E.M.F. M.

We have seen that, by suitably arranging the speed of the machine, N, we can cause it to act as a generator, when it will be able to furnish all or part of the effective currents required by the distributing cables.

It is not the same with the wattless currents.

In order that these might be supplied by the induction machine, it would be necessary that the difference, Q, between the product of the coefficients of self-induction of the primary and secondary circuits, and the square of the maximum value of the coefficients of mutual induction between the primary and secondary circuits should be negative. This condition will never be fulfilled in an induction machine with circuits closed on themselves, for the difference is always positive, and only becomes zero in a perfect machine.

If we connect several induction machines, such as the machine N, between the distributing conductors, A B and C D (fig. 7) all these machines will simultaneously produce effective currents, that which turns the quickest absorbing the largest amount of mechanical energy, and the converse.

These machines, then, should be able to be coupled together, without any condition as to synchronism, like continuous current machines. But the source of E.M.F. would always have to furnish all the wattless currents demanded by the distribution service, and those necessary for all the induction machines.

Suppose, now, that instead of coupling the source of E.M.F., M, and the induction machine, N, in parallel, we couple them in series, as represented in fig. 8, and that we wish to maintain a current of constant effective strength in a circuit in the form of a ring, including the source, M, one or more induction machines, N, and the circuit for the utilisation of the current called X.

By communicating a suitable speed of rotation to the induction machines, all would simultaneously produce electromotive forces of the same phase as the current; that one which turns the fastest would absorb the largest quantity of mechanical energy and reciprocally.

Induction machines can thus be coupled in series like continuous current machines, but they must be accompanied by a source of E.M.F. able to produce all the E.M.Fs. having a difference of phase of a quarter of a period with the current strength. We arrive then at the following conclusions:—

1. We can couple single-phase alternating induction machines, with closed circuits, in parallel, and branch them upon the distributing network. These machines will be able to furnish the whole of the effective currents required for the service of the network, but all wattless currents required for the same service, or for the excitation of the induction machines, must be furnished by a special source of E.M.F.

2. We can couple these same machines in series, in a circuit in the form of a ring; they will be able to develop all the necessary E.M.Fs. which are of the same phase as the current, but all the E.M.Fs. in quadrature with this last must be generated by a special source.

3. In both cases, the induction machines need not turn synchronously. Their coupling will be done like that of continuous current machines; that which turns the fastest will absorb the most mechanical energy, and reciprocally. These conclusions have been completely verified, first, in the workshops of the Maison Farcot, with machines of medium dimensions, and since at the works of St. Ouen, by means of the two alternators represented in fig. 4.

These alternators being furnished with damper (amortisseur) circuits, it was sufficient, if the primary of one of them was not excited, for that machine to become asynchronous.

We call attention particularly to the following experiment, which has been repeated many times since:—The two alternators being both excited, and connected in parallel, we suppress the excitation of one of them, and thus transform it into an asynchronous machine.

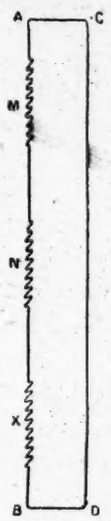


Fig. 8.

By looking at its crown of poles across that of the other alternator we see that its poles, which appeared fixed in space when the alternators were synchronised, take up a feeble motion, which represents the difference in speed of the two machines. It is that which is not excited which turns the fastest. We then cut off the steam from the engine of the alternator which is excited. It continues to turn, drawing its steam engine with it.

In these conditions the asynchronous machine furnishes all the effective currents necessary for the maintenance of the motion of the other alternator, which remains excited. This (the excited alternator), on the contrary, furnishes the wattless currents necessary for the excitation of the asynchronous machine.

Conditions that must be Fulfilled in order that an Induction Machine may always be Employed as a Generator.

In order that an induction machine may always be employed as a generator, it is necessary that instead of taking the wattless currents required for its own excitation from a primary source it should be capable of generating them itself, so that the currents required, effective or wattless, by the distribution service may be provided by it. For that it is necessary to render the quantity, Q, previously considered, negative, which we are able to arrange by diminishing, artificially, one of the coefficients of self-induction.

The following reasoning will show that it is the self-induction of the secondary which it is most convenient to diminish:—

In an induction machine, with closed circuits, the alternating current which develops the flux operating in the interior of the machine has a frequency, a. This frequency being always high, the apparent energy that must be furnished in order that this current shall pass, is much greater than the actual energy corresponding to the quantity of heat disengaged by its passage.

If this flux were developed by the currents traversing the secondary circuits, these currents would have to furnish the same number of ampere turns, around the same tubes of magnetic force, as the preceding exciting current, but they would only have practically one fourth of the frequency a. The apparent energy necessary to pass these currents would be very little greater than the real energy corresponding to the heat disengaged by their passage.

If we make the quantity, Q, negative by diminishing the self-induction of the secondary, the currents which will traverse the primary will only exercise a demagnetising action upon the flux crossing the circuits which they pass through, and this flux can only be developed by currents traversing the secondary circuits. Therefore by diminishing the self-induction of the secondary, we shall excite our machine with currents of low frequency, whereas we should always excite it with currents of frequency a if we diminished that of the primary.

In order to artificially diminish the coefficient of self-induction of a circuit it is necessary to add to the circuit an apparatus capable of furnishing a part of the apparent energy necessary in order to pass a given alternate current through it. It is evident that the dimensions of this apparatus will be smaller as it will have less apparent energy to furnish.

It is convenient, then, to transform an induction machine into a true generator by artificially diminishing the coefficient of self-induction of its secondary circuits, and not that of its primary circuit.

(To be continued.)

BOILER MAKING.

The art of boiler making in America differs considerably from English practice. True, much of the boiler plate used in America is most excellent, but even for the best the allowance of pressure is such as to startle some of our own more cautious engineers, while at one time certain boilers were allowed even an excess upon pressures already excessive. The Hartford Boiler Insurance Company—the largest company of the kind in America—has for years aimed at bringing American practice more into line with safe limits. An American writer, Mr. H. R. Barnhurst, states that rivets have been allowed as great a strength in shear as in tension, and he looks on this as a weakness. Of this we cannot speak. Certain, however, it is that, generally speaking, it is not the rivets in a burst boiler that have usually been found to have failed, but the plates have failed through the line of rivets. The calculation of a rivet seam is somewhat complex. A joint ought to part by simultaneously shearing the rivets and tearing the plates, but there is a third stress to be taken into account, namely, the bearing stress of the rivet on the plate, and there is also the question of tightness. It would, we imagine, be difficult to burst a boiler shell of first-class material and workmanship. It is more than likely that there would be so much leakage through straining as to stop the attempt.

Mr. Barnhurst gives 38,000 lbs. as the shear of a rivet. He states that the United States inspection rules allow a factor of six based on solid plate area. This, with a joint of 70 per cent., becomes only 4·2, and as 20 per cent. additional pressure is allowed for drilled holes, we get down to $3\frac{1}{2}$ only. Assuming elastic limits of only half the ultimate tenacity, we find a safety margin of barely 2, for after all the true limit of strength is the elastic limit, and not the ultimate strength developed in a rapid test. The author advocates hard and fast proportions for rivetted seams, and is also in favour of a considerable amount of official interference. It is a fact, we believe, that there is already a good deal of official interference in America in respect of boilers. Enginemen are more or less licensed, boilers are tested by the police authorities, and a fine farce this is. In Great Britain, so far, there is but little official interference, and yet the loss of life by boiler explosions is perhaps smaller than in any other country. Until the socialistic wave of the last few years swept over the country, and brought with it municipal trading and silly demands for Governmental interference with steam boilers, the common sense action of British steam users had developed a fairly perfect system of boiler insurance and inspection in Great Britain, and very little more is wanted to render our system as complete and perfect as present human nature can make it, that little being the necessary pressure upon careless steam users to compel them to take such precautions as will ensure safety.

There is no reason why a firm owning many boilers should not have their own inspector, and there is no reason why a man who owns or runs a boiler, and is himself a competent inspector, should not do his own work if he care to do so. But this is hardly advisable, and we believe even expert engineers prefer to call in the aid of the insurance companies, who have before them a continuous well of up-to-date experience and practice, and, to our certain knowledge, have brought to bear a very great influence for good on boiler making, keeping a salutary check on the too hasty adoption of novel material, and preventing the use of absolutely undesirable materials that are apt to be found sailing under false colours.

Mr. Barnhurst's tables for rivetting are too full to reproduce here. They are calculated for material of a tenacity of 60,000 lbs., rivets of 38,000 lbs. shear; an example must suffice. For a $\frac{9}{16}$-inch plate, treble rivetted with double butts, the rivet hole is $\frac{7}{8}$th inch, the rivet is $\frac{13}{16}$ths, and the pitch $6\frac{7}{8}$ inches. The strength is supposed to be 27,918 lbs. at 84 to 86 per cent. joint efficiency. No thickness is given for the butt straps. The working strength of a boiler is obtained by dividing the strength by the factor of safety and the radius. Thus for a shell of 8 feet and a factor of 6, the working pressure becomes 97 lbs., which is less than even our cautious English allowances for steel like this of nearly 27 tons tenacity. One important item overlooked is that as a boiler ages, if it does become corroded, it will be reduced at the rivet seams and chiefly on the plates. This points out that the plates exposed require to be a little stronger than calculation. Considerations of this sort obtain much more with lapped seams than with butts. The tables before us give no information on the pitch of the lines of rivets from each other, which is a very important matter. One could hardly punish a boiler maker for neglecting to keep rules set down in so doubtful a manner and leaving so much open.

It is not so much boiler makers that require a license. The license would tend to reduce boiler making to the disgraceful level of the authorised plumber's work. An authorised plumber appears frequently to use his license as a means of extortion only. If steam users were liable for their carelessness, they would soon see to it that their boilers were safe. Give them the option of buying from an authorised maker, and the bad ones would shelter themselves behind the phrase.

(To be continued.)

source.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Oct. 10th, 1899.		Week ending Oct. 9th, 1900.	
Amsterdam	Value £26	Alexandria	Value £413
Antwerp	63	Auckland	20
Auckland	220	Brisbane	30
Beira	118	„ Teleg. cable	178
Bombay	54	Buenos Ayres Teleg. mat.	456
Buenos Ayres	124	„ Teleg. wire	343
„ Teleg. mat.	332	Calais Elec. Fuses	52
Canterbury	50	Calcutta	106
Cape Town	389	Cape Town	313
Calcutta	260	„ Telephones	50
„ Teleg. wire	50	Colombo	305
Chinde. Teleg. mat.	1,576	Copenhagen	30
Christiania. Teleg. wire	162	„ Teleg. wire	132
East London	399	Durban	452
Gibraltar	18	East London	15
„ Teleph. appar.	135	Fremantle	66
Gothenburg	53	Gibraltar	90
Grenada	12	„ Teleg. apparatus	668
Halifax	160	Grenada Teleg. mat.	28
Hong Kong	672	Jamaica	112
Madras	101	Lyttleton	286
Melbourne	442	Malta	156
Montreal. Teleg. mat.	60	„ Teleg. mat.	152
Ostend	241	Melbourne	102
Penang	39	„ Teleg. mat.	861
Port Elizabeth	91	Ostend	134
St. Petersburg.	206	Perth	160
Singapore Elec. plant	1,104	Port Elizabeth	119
Stockholm. Teleg. wire	194	Rio Janeiro	47
Sydney	428	Rotterdam	250
Tienstin	17	„ Teleg. mat.	98
Vancouver. Teleg. wire	72	St. Petersburg. Teleg. mat.	54
Wellington	347	Saigon	20
		Shanghai	169
		Singapore	14
		Stockholm Teleg. mat.	150
		Sydney	1,367
Total	£8,110	Total	£7,928

Foreign Goods Transhipped.

Brisbane Teleph. apparatus	£168

Bankruptcy Proceedings.—The first meeting and public examination of T. W. Greaves and W. G. Randall (T. W. Greaves and Co.), electrical engineers and cycle manufacturers, are to be held at Bankruptcy Buildings, W.C., on October 18th and November 15th respectively.

Notice of a first and final dividend of 2s. 5½d. in the £ in the case of B. Symmons, electrical engineer, Brighton, is given in the last issue of the *London Gazette*.

Liquidation.—The Land and Water Electric Power Syndicate is winding up voluntarily with Mr. S. B. Saunders, Bush Lane House, E.C., and Mr. J. B. Childe, of Bradford and London, as joint liquidators, with a committee to assist.

Belgian Electrical Material in England.—In the report of the Société Electricité et Hydraulique, of Charleroi, for the last financial year, it is stated that in 10 months its London office has secured orders to a value of £44,000.

Books Received.—"Motor Vehicles and Motors," by W. Worby Beaumont. London: Archibald Constable & Co., Ltd. 42s. net.

"Electric Wiring Tables," by W. Perren Maycock. London: Whittaker & Co. 3s. 6d.

"Elementary Questions in Electricity and Magnetism," by M. Maclean and E. W. Marchant. London: Longmans, Green & Co. 1s.

"Thermo-dynamics of the Voltaic Cell," by H. S. Carhart. Reprinted from the *Physical Review*.

Bristol.—Messrs. Gilbert J. Lloyd & Co., of Bristol, are at present busy with private plants and motor work in the district, having just completed a large plant for the new Sanatorium on the Mendip Hills, for consumptives, consisting of steam engine, &c., dynamo, accumulators for 150 lights, together with a complete telephone equipment. The firm's tender also has just been accepted for lighting the Newport workhouse with 1,000 lights.

Campion v. The Land and Water Electric Power, Limited.—In the Vacation Court on Wednesday, before Mr. Justice Buckley, the case of Campion *v.* The Land and Water Electric Power, Limited, was mentioned on a motion for a receiver in a debenture holder's action. Counsel stated that only one debenture had been issued, and it had now been arranged that the liquidator of the company should take a transfer of the debenture, in order that the proceedings might be stayed. On this understanding, the motion would stand over generally with liberty to restore, if the terms arranged were not carried into effect.

Catalogues and Lists.—The Simplex Electrical Company, of Cambridgeport, U.S.A., sends us an illustrated catalogue (No. 6) of electric heating apparatus. Electric kitchen equipments, ovens, stoves, warmers, urns, tailors' irons, heating pads, glue pots, radiators, foot warmers, and a variety of other apparatus are illustrated and priced; some general information is given regarding the cost of operation, and the time for cooking food and warming water is mentioned.

Messrs. John Spencer, Limited, of Wednesbury, issue a neat catalogue (a new and revised edition) detailing their iron and steel tubes and fittings of all kinds, including telegraph poles, arc light masts, and trolley poles (single and double arm).

Messrs. Ernest F. Moy, Limited, have published new illustrated lists of their shunt regulating resistances, voltmeter switches, maximum cut-outs, and "Acme" patent switches (double and triple pole).

A convenient sized wall card, 9 inches × 14 inches, giving in tabulated form a note of the standard sizes of conductors for electric supply mains, has been issued by Messrs. Johnson & Phillips.

The Waltham Art Metal and Engineering Company are sending out lists showing designs of some very artistic switches now being supplied by them.

Messrs. Hands, Limited, are circulating a list of a "perfect watertight fitting" being supplied by them for street, shop front, and factory lighting.

Messrs. Le Carbone, of Lime Street, E.C., have sent out lists of their primary batteries (Lacombe, Sack, Sans Pareil, &c.), Boudreaux dynamo brushes, carbon brushes, arc lamp carbons, &c.

Mr. G. Braulik has forwarded to us an illustrated pamphlet describing his patent couplings for arc lamps, arc lamp winches and accessories, &c.

Messrs. Abbott & Co. (Newark) Limited, have just issued a new pocket price list of their "handy hoists." Among other things shown therein, is a special arc lamp hoist with detachable handle, ratchet, and brake. This, and the many small hoisting appliances particularised in the list, will interest electrical engineers.

A little pamphlet comes to hand from Messrs. C. A. Parsons and Co., in which is given a list of corporations and companies in this country, also Governments, mills, factories, and public institutions, and so on, for which turbo-alternators have been installed during the past five years or are now on order.

Messrs. Priestman Bros., Limited, have sent us an illustrated circular of their oil engines.

The Warwick Trading Company, Limited, of Warwick Court, W.C., have issued a catalogue of animated picture specialities. The Bioscope, and other apparatus, also films and accessories of great varieties, are particularised, and numerous illustrations are included.

The Dudley Free Wiring Contract.—Under the heading "Kenilworth" last week, we mentioned that the free wiring contract for Dudley had been given to the Birmingham Installation Company. We have now received the following letter:—"We note that in your "Business Notes" you state that the Birmingham Installation Company have secured the contract for the free wiring of Dudley. Will you kindly state in your next, that out of many tenders for the free wiring, three tenders were recommended for acceptance, namely:—(1) Our own, being the only local tender accepted; (2) The Birmingham Installation Company; and (3) Messrs. Frazer & Co., of Birmingham. As the Local Government Board inquiry was only held this week, and the matter is not settled at present, it cannot be said that any firm has secured the contract. Mr. R. P. Wilson, of Victoria Street, is the consulting engineer to the Corporation of Dudley, and he alone can give information in the matter. It may be of interest to state that the Kidderminster Electric Light Company is now giving supply, and that we are just now wiring the Kidderminster Town Hall, Municipal Buildings, Free Library, and other buildings.—Whittaker Bros., Kidderminster."

Electricity for Mines Drainage.—At the annual meeting of the South Staffordshire Mines Drainage Commissioners last week, Mr. J. B. Cochrane, the chairman, intimated that the Commissioners looked forward to shortly having electric pumps at the works for the purpose of unwatering the mines in the South Staffordshire district.

For Sale.—The British Thomson-Houston Company is offering for sale a number of machine tools, including lathes, shaping machines, drilling machines, band saw, grinders, &c. See our advertisement pages this week.

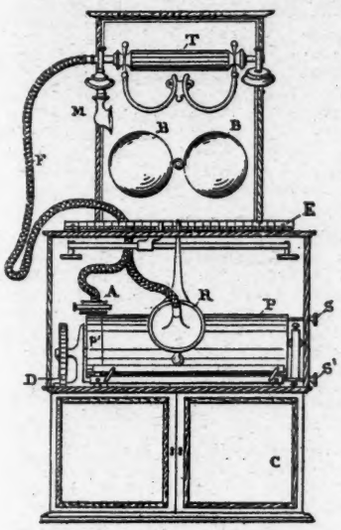
Messrs. Wheatley Kirk, Price & Co., will offer for sale by auction, by order of the liquidator of the Ormonde Cycle Company, Limited, the leasehold works and premises, plant, fixtures, &c., of that company, situated at Hornchurch Road, Romford, Essex; also the business and London depôt of the company as a going concern. Particulars will be found among our advertisement pages this week.

Electrical Imports.—The value of the imports of foreign electrical goods and apparatus into the United Kingdom during September last, amounted to only £97,107, as compared with £148,317 in the preceding month. The total for the first nine months of the current year is given as £794,699.

Strike.—On Thursday of last week, the employés at the electric car works, Hadley, near Wellington Salop, struck work in order to support 40 others who had been locked out for a fortnight for objecting to the employment of unskilled workmen upon certain machines.

The Telephonograph.—This invention, which is a combination of the phonograph with the telephone, consists of a mechanical device (inside the electro-magnetic recording diaphragm cell R) which increases and multiplies the impulses of the electrical vibrations, and thereby cuts clean and deep sound waves in the coating of an interchangeable cardboard cylinder P, measuring 10 inches in length and 5 inches in diameter. By revolving the cylinder the record is made at 150 spirals to the inch, and the number of words which may be thus taken down when the whole length of cylinder is covered is some 15,000, which would represent a page of an ordinary newspaper. There is also a second cylinder P', an inch broad, but of same diameter as its fellow P; the function of this cylinder is to take the place of an attendant, and to answer calls When the person who is called up is at hand, he disengages

the automatic speaker A, by means of the lever S', and if he chooses to take his message without recording it phonographically, he can do so by pulling the upper lever S. M is a special mouthpiece having a separate channel for conveying the sound waves directly to the recording stylus of the home station. On the scale bar E slides a pointer which must be pushed against the tail of the electro-magnetic diaphragm R, when leaving the office; the machine is then ready to record messages received during absence. C is the battery and motor case. The other details of the sketch are common with ordinary telephonic instruments. By means of the apparatus the words of bargains and figures transmitted by telephone, which would be otherwise lost, are retained, and can be reproduced by the instrument so as to be available in the settlement of disputes. The telephonograph was invented by Mr. E. O. Kumberg, of Kilburn. We understand that his experimental work was done through the kindness of Mr. Higgins, chief engineer of the Exchange Telegraph Company; an experimental machine can be tested at the offices of Messrs. Henry F. Joel & Co., Wilson Street, Finsbury, E.C.



Rubber in Rhodesia.—Those interested in the rubber industry will find valuable information regarding Rhodesian rubber supplies in a 30-page pamphlet (by P. Lyttelton Gell), published by the British South Africa Company. It summarises the main points relating to the industry, so far as they are important to the administration of the British South Africa Company. The sources of rubber are described and the administrative policy of the company is outlined in some detail. The conclusions arrived at are briefly stated as follows:—

1. All rubber extracted should contribute to the revenue; but different principles will apply to the product of wild rubber and of cultivated rubber in reserved areas.
2. Wild rubber trees should be regarded as a capital asset of the Company, and as an important source of future revenue. Rubber areas should not be alienated, but should be worked as a branch of Forest Administration, either (*a*) directly by the Company through a Forest Department, or (*b*) by subsidiary companies in which the British South Africa Company retains a controlling interest, or (*c*) defined areas may be let for an annual revenue on terminable leases under strict covenants to responsible parties undertaking the systematic cultivation of rubber.
3. Immediate legislation is necessary to regulate the industry and protect it from extirpation. The attention of the Company's Administrators in each of the four provinces should be invited to the question, and draft Ordinances might be prepared. The co-operation of the Imperial Authorities in the British Central Africa Protectorate is desirable, if it can be obtained. Though in advance of Rhodesia, the Protectorate has at present no comprehensive regulations for the preservation of rubber.
4. No monopoly in the extraction of wild rubber should be granted, and any proposal to derive revenue from duties upon extraction should be discouraged as injurious to the industry, though to secure the necessary control, outsiders proposing to extract rubber in a district must obtain a local license, for which substantial fees may be properly charged.
5. A duty of, say, 3d. a lb. should be levied on all traded rubber, which would be payable by the trader at the time of purchase from the extractor; but, in the absence of a receipted pass accompanying the rubber, it may be levied as an export duty.
6. All traders in rubber should take out a special district license, which will be available only within the district specified.
7. A small scientific Department of Forestry seems to be indispensable, not merely in the interests of rubber, but for the systematic control of forest areas throughout the Company's territories (see Report, 1897-8, p. 140, &c.). Such a Department ought to be made a source of profit. All rubber-bearing trees observed in different localities should be reported by the Company's officials, and the Department (to which a man having technical knowledge of rubber should be attached) would advise on their value and the best methods of extraction and preparation. It would also distribute to them and to others specimens of foreign trees to be planted and reported upon.
8. As regards cultivated rubber, every encouragement should be given to the investment of capital in the systematic cultivation of rubber in reserved areas, let on terminable leases at progressive rents. There is no reasonable ground for wholesale land grants. A few thousand acres of selected land will profitably absorb much capital and energy, though options to extend when the first area is fully planted may be desirable. 10,000 acres is the area reserved by the Indian Government for its cultivation of rubber in Burmah.

Trade Announcements.—The business of Messrs. Polland & Co., of St. Nicholas Buildings, Newcastle-on-Tyne, has been taken over by the Union Cable Company, of 23, College Hill, Cannon Street, London, E.C., as from August 24th. Debts due to Messrs. Polland, will be paid by the Union Company, and debts due by them will be attended to by Messrs. Polland from the College Hill address. The Union Cable Company manufactures all classes of electric cables for lighting, transmission of power, telegraphy, telephony, &c., and large quantities are kept in stock.

Mr. J. Wemyss Anderson, A.M.I.C.E., M.I.M.E., has arranged a partnership with Mr. Alfred Hay, B.Sc., M.I.E.E., and in this connection business will be carried on as consulting electrical engineers at Pearl Assurance Buildings, Liverpool.

Trucks.—The Brush Electrical Engineering Company have now taken up the manufacture of traction trucks at their Falcon Works, Loughborough, Leicestershire. Their standards are three in number, which cover the general needs of electric traction in this direction, namely:—The four-wheel single type; the four-wheel bogie type; and the maximum traction type. A special shop has been erected and equipped, under the control of Mr. E. E. Cook, an engineer who has had long and successful experience in this branch of manufacture in the United States. The company is, therefore, in a position to quote to any specification, and to handle orders of any probable magnitude.

ELECTRIC LIGHT AND POWER NOTES.

Austria.—A large electric lighting and power plant has recently been installed by Messrs. Ganz & Co., of Buda-Pesth, in the works of the Floridsdorf Locomotive Company at Floridsdorf, near Vienna. The generating plant comprises two 300-H.P. steam dynamos and a smaller set of 120 H.P. The plant supplies current for 35 arc and 600 incandescent lamps, as also for several cranes and 60 electromotors.

Australia.—A Sydney newspaper says that the Sandon Electric Light and Power Works at Armidale have been sold to a London firm for £25,000.

Birkenhead.—The members of the E.L. Committee of the Birkenhead T.C. made their annual inspection of the estate under their charge last week. During the past 12 months the engine power at the Craven Street works has been doubled, and on the morning of the inspection a 500-H.P. engine had been yoked to a dynamo for the first time.

Bombay.—The two committees appointed to advise the Corporation on the subject of electric lighting and electric tramways have not yet been able to complete their reports on these matters. The firms who have made offers are as follows:—Turner, Hoare and Co. (agents for Messrs. Siemens); J. Foster, electrician to Messrs. Greaves (cotton mill owners); Messrs. Killick, Nixon & Co. (agents for Messrs. Callender's Cable Company). An extra application was also received from a large firm. Doubtless by this time the report has been submitted. The Tramway Company are very anxious to proceed with their undertaking, but are blocked in the adoption of electric traction, as they wish for a renewal of their lease for a long period.

Bradford.—At the last City Council meeting Mr. T. H. Shaw, chairman of the Electricity Committee, moved the minutes of that committee, and in doing so read the report of the work of the electricity department during the half-year ended on June 30th last. He stated that the total income for the half-year was £17,723 9s. 5d., as compared with the corresponding period in the preceding year of £13,256 12s. 11½d., or an increased income of £4,466 16s. 5½d. The total expenditure for the half-year (including interest and sinking fund) was £16,751 1s. 3½d., as against £11,523 10s. 4d. for the corresponding period of the preceding year. The net profit for the half-year, therefore, was £972 8s. 1½d., as against £1,733 2s. 7½d., being a decrease of £760 14s. 6d. on the corresponding period of the preceding year. The number of consumers was 1,178, as against 965, or an increase on last year of 22 per cent. The total number of units consumed was 1,449,409, against 996,807, or an increase of 45 per cent. (irrespective of current supplied for public lamps). The total profit since the opening of the electricity works (in September, 1889), to June 30th, 1900, after paying interest and sinking fund, amounted to £26,986 0s. 6½d., and the total amount written off for depreciation has been £14,372 17s., leaving the sum of £12,613 3s. 6½d. to be appropriated as the Council might direct. The trade profit—that is, the profit before charging interest and sinking fund—for the half-year ended June 30th, 1900, worked out to £3 7s. 2d. per cent. on a capital outlay of £241,838 8s. 11d., and the net profit, *i.e.*, after charging interest and sinking fund, shows a percentage of 8s. on the same outlay. Taking the June half-year and the preceding December half-year together, the trade profit amounted to £18,186 14s. 1d., representing £7 10s. 5d. per cent. on the capital outlay. The net profit for the same half-years amounted to £4,369 13s. 10½d., and represented £1 16s. 2d. per cent. on the capital outlay.

Bristol.—The Consolidated Petroleum Company, Limited, has just entered into arrangements with the Bristol Docks Committee for the establishment of a large depôt close to Avonmouth Dock, and in connection with their works they needed electric lighting. The Docks Committee have recently established a generating station at the Docks for motive power and lighting, and asked the Council's consent at the meeting on Tuesday to enter into a contract with the Petroleum Company to supply the current the

latter needed. Alderman Pearson, the chairman of the E.L. Committee, pointed out that it was a not very desirable arrangement to have two civic committees supplying electricity, and possibly competing with each other, and suggested that it might be found that the Corporation works at Bristol conducting operations on a large scale, could supply the dock at Avonmouth more economically than current could be produced on the spot. The chairman of the Dock Committee explained that it was too late to entertain the proposal, as the works were being established, and further speeches elicited the fact that the Docks Committee, before setting up as producers of electrical energy, approached the Electrical Committee, but the latter did not feel justified in carrying their mains to Avonmouth, which is at least half a dozen miles from the centre of the city. The Council approved of the Docks Committee's proposals.

Coventry.—At a meeting of the E.L. Committee this week the manager's report showed an increase in consumption for the month of September of 42½ per cent., but the increased cost of coal is affecting the working adversely.

Dudley.—On Friday last Mr. H. P. Boulnois, on behalf of the L.G.B., inquired into the T.C.'s application to borrow £10,000 for electric lighting in Dudley. It was explained by Mr. R. P. Wilson, consulting engineer to the Council, that the money would be spent in accordance with the resolution to wire houses free for electric lighting purposes. The charge to consumers would be 6d. per unit for two hours, and 1½d. for the remaining 22. The tramways at present were the only consumers, and the company were paying 2d. per unit for the first 150,000 per annum, and less in proportion as the quantity increased over that amount. They had supplied the tramways with 196,000 units during the past year, and a total consumption of 270,000 would be reached per year when the electric lighting was established.

Dungannon.—The U.D.C. has appointed Mr. G. Coombe, of Belfast, to report upon the proposed electric lighting of the town.

Epsom.—Delay in the introduction of electric lighting at Epsom has occurred through the original estimate for the cost of the installation being exceeded by £2,200, making the total cost, with contingencies, £18,300. Before contracts are signed further application will have to be made to the L.G.B. to increase the loan.

Glasgow.—The Electricity Committee have intimated that the new power station at Port Dundas will be open for inspection by electrical engineers and others interested on Saturday, 13th inst., from 3 to 5 p.m.

Heckmondwike.—The E.L. Committee reported at a meeting of the D.C. last week that the L.G.B. had sanctioned the borrowing of £14,343 for the purposes of electric lighting.

Hereford.—The T.C. has come to a final agreement with the contractors for the electricity works (the Silvertown Company), the latter providing a spare armature, free of cost, in satisfaction of their liability in respect of penalties for delay. The necessity of extension of the electricity works is already making itself felt.

Ince.—The D.C. on Wednesday decided to apply to the Board of Trade for a provisional order for electric lighting. The population is about 20,000.

Kingston-on-Thames.—An attack has been made on the Corporation by Mr. C. Bolton, J.P., who arranges the statistics of the Corporation electricity department to support an allegation that the undertaking does not pay. From the official accounts, Mr. Bolton alleges that he abstracts figures showing the net deficits in the years 1895—9 to have been £1,555 9s. 4d., £1,266 5s. 5d., £1,131 13s. 3d., £1,469 19s. 10d., and £942 11s. 6d. The figures given by Mr. Bolton are not in accord with those presented to the Corporation last March, showing that the net deficits for the same periods were—£1,382, £1,326, £791, £1,112, and £47.

London.—Hackney.—A special meeting of the Vestry took place last week, when tenders were received for the supply of electricity mains, and for the constructional ironwork required in connection with the buildings of the combined electricity and refuse destructor works. The tenders were referred to the E.L. Committee.

Maidstone.—The E.L. Committee of the D.C. has recommended certain alterations in the original scheme in accordance with a report of Sir W. H. Preece; the plant is to be increased, the floor of the station raised above the highest flood level, an additional feeder laid, and the public arc lighting extended, at an additional estimated cost of £4,048. These recommendations were agreed to.

Moffat.—The question of a scheme of electric lighting for the burgh has been considered by the Commissioners. Mr. W. B. Forman, electrical engineer, has been interviewed on the subject, and is satisfied that a scheme of electric lighting by water-power could be carried out with profit to the burgh. The Commissioners have appointed and empowered a Committee to arrange with Mr. Forman to prepare plans and report to the reconstituted Commission.

Newport (Mon.).—At the last meeting of the E.L. Committee the office manager submitted a statement showing that the sum of £91,235 had been expended upon the electric light undertaking, that £80,815 had been sanctioned, and that a further sum of £30,000 would be required to make up this difference and to cover the cost of further extensions of mains and transformers, and of the proposed changing over to the 250-volt system. It was, therefore, resolved that application be made to the L.G.B. for leave to borrow a further sum of £30,000.

Oldham.—An application by the Failsworth D.C. for terms for the supply of electric energy to their district has been declined by the Oldham Corporation. At a meeting of the Oldham T.C. last week the chairman of the Electric Lighting Committee stated that the present station was started more with the idea of keeping companies out of the town than from any love they had for electric lighting, and on that account the station had been in a great measure cramped. That fact had been a matter of very great inconvenience and expense to the Committee. Seeing the success that had followed the work of the Committee with the old station, the present Committee thought in starting afresh they would certainly be able to provide for the next 20 years by the system they were proposing to the Council. He reported that upon a revised plan and estimate of the proposed electric light and power station at Greenhill, together with a report of Prof. Kennedy thereon, being submitted, the Committee recommended that the Council instruct the town clerk to make application to the L.G.B. for its sanction to the borrowing of £157,000 for the purpose of erecting a station for the supply of electrical energy for lighting and power, and for tramway purposes. The recommendation was adopted. On Thursday (the 16th inst.) Mr. A. P. Trotter was to hold an L.G.B. inquiry for that purpose.

Richmond.—Mr. W. Wisdom, whose tender for the erection of the new Infirmary for the Richmond Guardians was accepted, being £1,400 below the next on the list, found that he accidentally omitted to add up an amount of £578 for electric lighting fittings. Mr. Wisdom applied to amend his tender before the contract was sealed, and consequently the board, after a lengthy discussion, has decided to ask for fresh estimates from all the firms interested.

Ryde.—The L.G.B. have given their assent to the application of the T.C. to borrow money for the electric lighting undertaking.

Stirling.—The Lighting Committee have reduced the charge for the supply of electric light to basement premises lit during the day from 5d. to 4d. per unit.

Stockport.—The R.D.C. has resolved not to proceed with the provisional order for the electric lighting of the district.

Stroud (Gloucestershire).—A special meeting of the U.D.C. was held last week to consider the desirability of applying for a provisional order for the electric lighting of the district. After some discussion, the meeting was adjourned for a fortnight for the purpose of further considering the matter.

Swindon.—The two D.Cs. have decided to borrow the sum of £31,000, upon the necessary permission of the L.G.B. being obtained, for the purpose of carrying out the first portion of the electric light scheme for the town.

Warwick.—At a meeting of the T.C. on 9th inst. the British Electric Traction Company gave notice that they intended to apply for a provisional order to supply electric lighting for the town.

Weybridge.—In view of the coming introduction of electric lighting by the Staines and Weybridge Supply Company, the local gas company has made a reduction of 5s. per lamp for public lighting for the Weybridge district.

Weymouth.—The T.C. met yesterday to discuss whether to apply for a provisional order.

Wolverhampton.—The E.L. Committee have resolved that from November 12th next, the charges to consumers of electrical energy to the extent of 12,000 units and upwards annually, be as follows:—

Units per annum.	Price per unit.
12,000 to 20,000	4d.
20,000 to 30,000	3·75d.
30,000 to 35,000	3·5d.
35,000 to 40,000	3·25d.
40,000 and upwards	3d.

ELECTRIC TRACTION NOTES.

Blackburn and Burnley.—The Light Railway Commissioners have recommended the B. of T. to grant an order authorising the construction of a line connecting Blackburn with Rishton, Whalley, and Burnley. The plans prepared by Mr. C. Chadwell, of Blackburn, engineer to the promoters, shows that the total length of line, which is to be double throughout, will be 14 miles, and the estimated cost is £154,000. The County Council have made it a point in their attitude towards the undertaking that the county ratepayers should not be asked to subsidise it to the extent of a penny piece by the widening of roads or bridges.

Blackpool.—The offer of the Blackpool and Fleetwood Tramroad Company to supply electricity temporarily to the Corporation tramways at 2d. per Board of Trade unit has been accepted.

Colchester.—The Corporation having decided to apply for a provisional order, Messrs. Massey & Allpress, of Westminster, have been engaged as consulting engineers to carry out the preliminary work for the tramways scheme.

Edinburgh.—It is well known that the City of Edinburgh possesses a very extensive system of cable trams, but the numerous accidents which have arisen from time to time have given rise to a good deal of dissatisfaction. We read in the *Glasgow Herald* that at a meeting of the Edinburgh Town Council on 2nd inst., Judge Kellock moved that, in view of the electric tramway to be run from Musselburgh to Joppa, and the importance and convenience to the public of a through service to Edinburgh, that it be remitted to the Lord Provost's Committee to consider the whole question of traction between Edinburgh and Joppa, with powers to employ skilled experts and report. Lord Provost Sir Mitchell Thomson pointed out that the route had already been cabled at the anxious desire of the lessees, who had given as their reason that a uniform system of traction would enable them to use cars from other parts of the city on the Portobello route. Judge Kellock held that the circumstances had changed since cabling was decided on by the Council. Particularly there was this matter of the electric tramway to Musselburgh. Electric traction had also been greatly improved. The Lord Provost: Are you aware that the route has been cabled long ago?—Judge Kellock: Yes; but the question is whether this cabling might not be utilised for underground electric traction.—Was the Council so impotent in the hands of the lessees that it must simply do what they wanted?—The Lord Provost said they had an honourable undertaking to go on with cabling.—Judge Kellock: If we can show the lessees a cheaper method of traction, surely it is to their interest.—Judge Steel said the matter had been inquired into, and they had been informed that the cabling work done was unsuitable for an electric tramway.—Dean of Guild Ormiston seconded the motion. He thought an electric power station in Portobello would form an admirable centre for Portobello and Musselburgh. He had not much faith in the anxiety of the parties who were constructing the cable tramways to get on with the work. They had had a magnificent object lesson of that in Edinburgh, and he did think it would be advisable to reconsider this matter. The motion, on a show of hands, was defeated by a large majority.

If the Edinburgh Corporation wishes to know how to set about the conversion of cable to electric tramways, we would refer it to the reconstruction works now proceeding in connection with the Broadway cable line in New York City. It is only eight years since horse haulage was abandoned here in favour of cable, and now it speaks volumes against cable traction to mention that this the last prominent cable line in the United States has gone over to electricity. Some photographs showing the conversion work in actual progress appeared in the *Electrical Review* (N.Y.) for September. The Broadway lines of the Metropolitan Street Railway Company represent probably the busiest piece of street railway track in the world. As a preparation for the change to electric operation by the underground trolley or open-slot conduit system, the company has begun the relaying of the rails on this track and the placing in of the hand-hole boxes in which the insulators to carry the two steel conductors of the electric system will be placed. It is expected that the cable will remain in operation until some time early in the Spring of 1901, when the conductors will be installed in place and electric cars will supplant the grip cars on the busiest artery of the metropolis. The new track that is being laid consists of 110-lb., 7-inch grooved girder rail. It is quite likely that if the track were being entirely rebuilt to-day a deeper section would be used, but at the time that the cable road was constructed, in 1892, a 7-inch girder rail was considered an extremely heavy section for street car service. This fact is mentioned by our contemporary as an illustration of the rapidity with which electric traction has developed, and its extraordinary influence upon street railway engineering. Of course, with the present yokes and foundations of the Broadway track it will not be possible to replace the rails with those of deeper section. The composition of the rails has been chosen with great care in order to secure the hardest steel that could commercially be manufactured and handled. The result is that the new rails contain between 0·55 and 0·65 per cent. carbon and are calculated to withstand for a long time the exceedingly heavy traffic of street cars and wheeled vehicles on the Broadway. The rails will not be bonded since no current is returned to them, but will be connected together with eight-bolt fishplates.

Electric Mail Carts.—We read in *L'Electricien* that the postal authorities of Germany have just acquired for the municipality of Frankfort, which already possesses electric tramways, seven automobile cars and the same number of trailer cars. All these vehicles have been converted into mail carts. By this means a great saving of time and money has been effected in the transport of letters. The service of Frankfort, which formerly, with the ordinary carts, necessitated 40,000 journeys annually, is now reduced to 20,000 journeys with the electrical carts, although the service is now much more developed.

Glasgow.—At a special meeting of the Tramways Committee it was decided that Messrs. McCartney, McElroy & Co. should at once proceed with the overhead work for the tramway extensions in Alexandra Parade, Cumbernauld Road, Keppochill Road and Great Western Road, and that the Lorraine Steel Company should proceed with the special track work for these lines, including crossings, points, &c. The subject of these contracts was sent back to the Committee at the last Council meeting with powers.

Glossop.—A supplemental agreement with the Urban Electric Supply Company, Limited, with respect to the proposed tramways in the borough has been adopted by the Council.

Italy.—Good progress is being made with the conversion of the Bologna-San Felice Railway to an electric line. It is expected that traffic will be started in a few weeks.

New York Underground Railway.—According to *Engineering*, the contract for this rapid transit line was awarded to Mr. J. B. McDonald, of Park Row Building, New York. Mr. McDonald divided the work into 15 sections and sublet contracts for them. Each of the contractors, who are to build the various sections, will perform all work complete on the sections which were awarded them. Besides the machinery and apparatus required in performing the work of tunnelling, the respective contractors will equip their sections complete, this work requiring ventilating plants. The tunnelling in all the sections above Union Square will require considerable rock drilling and blasting. For this purpose certain of the contractors are purchasing air-compressing plants and the necessary accessories. In certain of the sections running through Harlem, viaduct work will be necessary where the line emerges from the tunnel and runs overhead. Work is now being started simultaneously on all sections. Three years will be required for the completion of the line. Some details of the tunnelling work in connection with this system were given in the Electrical Review for February 16th, 1900.

Newport (Mon.).—The sub-committee appointed to consider the whole question of carrying out the scheme of electric tramway traction and power supply, conferred with Mr. Parshall upon certain details in connection with the proposed installation, when it was decided to provide, in the first instance, for putting down four sets of plant of 500 kw. capacity, which would be capable of dealing with the whole of the tramways and a considerable demand for power. It was also decided that room should be provided in the generating station for laying down additional plant. The question as to whether the engines should be run non-condensing or otherwise, the type of boilers to be specified, and other details were also discussed, and will be dealt with in the report by the engineer.

Portsmouth.—The Board of Trade having suggested that on the introduction of electric traction by the Corporation, on the transfer of the tramways from the Provincial Tramways Company, the cars should be fitted with rheostatic electric brakes, the Tramways Committee decided that a deputation should interview the authorities. The adoption of the suggestion as to the brakes would have involved an expenditure of £20 per car, or £1,600 in all, It was pointed out that the rheostatic brake was intended more particularly for hilly districts, whereas Portsea Island is a flat district, and that the electric safety brake which had been provided for was amply sufficient. The members forming the deputation succeeded in satisfying the Board of Trade officials, and consequently the Portsmouth cars will not have to be fitted with rheostatic brakes.

South Staffordshire.—It is stated that the British Electric Traction Company have, in consequence of the delay in the arrival of the Board of Trade certificate, decided to temporarily discontinue running cars between Cradley Heath, Old Hill, Netherton and Dudley. The company have adopted a 20 minutes' service on the Sedgley route, and it is hoped shortly to have a quarter-of-an-hour service.

Southport.—The Southport electric cars are to be fitted with "never wet" seats.

Stirling.—Negotiations are again proceeding with the Stirling Police Commissioners and the Electric Traction Company in connection with the purchase and conversion of the tramways.

TELEGRAPH AND TELEPHONE NOTES.

Belfast Telephones.—The Belfast Corporation has under consideration the desirability of establishing a municipal system in the telephone area of Belfast, which includes the district of Larne, and is shortly to send a deputation to the Larne T.C. to lay the matter before it.

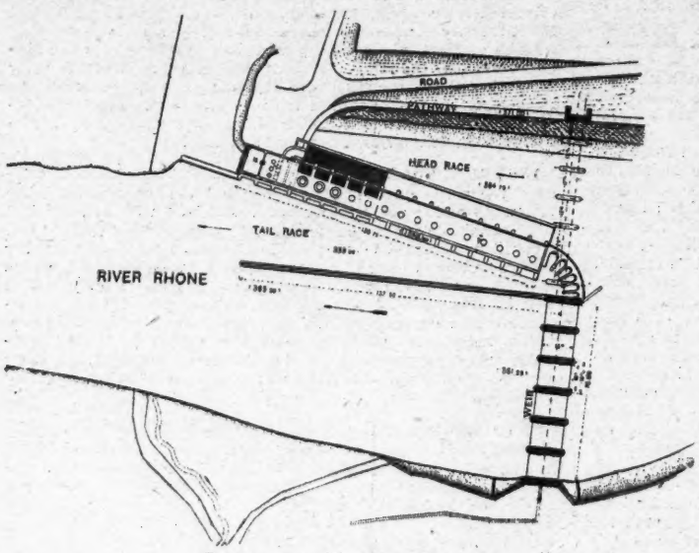
The Chifu-Tsin-Tau Cable.—Reuter's Berlin agent stated on 5th inst. that the cable which was laid between Chifu and Tsin-tau for account of the German Government was opened for the transmission of messages on 4th inst. The territory of the Kiao-chau is thus joined to the international cable system. No change will be made in existing rates.

The Telegraph Wire Export Trade.—After a long spell of activity the export trade of the country in telegraph wire and apparatus connected therewith appears to have entered upon a quiet time. The value of such exports during the past month only amounted to £80,248, as compared with £724,212 in the previous month, and £44,512 in September, 1899. The activity which has prevailed in this branch of trade this year is well indicated by the fact that the value of the shipments during the nine months ending with September reached a total of no less than £2,469,476, as contrasted with only £731,337 in the first nine months of 1899.

(*Continued on page* 591.)

THE ELECTRICITY WORKS OF CHÈVRES (GENEVA).

As long ago as 1880, the Corporation of Geneva was distributing power generated by the waters of the River Rhône; and in 1882 the town obtained a concession authorising the Corporation to make use of the whole power of the river traversing Geneva, to utilise 6,000 H.P. at Coulouvrenière, and to exercise control over the Lake. The works at Coulouvrenière were begun in 1883, and commenced operations in 1886.



PLAN OF THE WORKS AT CHEVRES.

However, the demand far exceeded the supply, and in 1892 the Geneva Government was applied to for the concession of another fall, giving a power more than three times as great as the first; this was the origin of the electricity works of Chèvres, the subject of the present article. It was found necessary later on to apply for a third fall, still more powerful than the second.

The Chèvres works were not carried out without meeting with those difficulties to which all hydraulic undertakings are subject; at the time when it became necessary to start on this great work, there did not exist any similar undertaking which had passed through a parallel experience. The way had to be shown, and it was not possible to profit by the experience of others, as it is now.

The work has at length been completed, and electrical energy is now distributed for all purposes in the Canton of Geneva; it is, therefore, an opportune moment to examine some of the difficulties overcome, and the successes achieved.

After the year 1886, the development of the hydraulic service was continually increasing, so that the groups of pumps and turbines, Nos. 1, 2, 4, 5, and 6, erected in 1886, were added to as follows:—

1887, one pump turbine	... ...	Set No. 3
1888, two " "	... ...	Sets Nos. 7 and 8
1890, " " "	... ...	" 9 " 10
1891, " " "	... ...	" 11 " 12
1892, " " "	... ...	" 13 " 14

It was, therefore, foreseen that this regular increase would continue in the following years, and that the day would arrive when the power of the Rhône at Coulouvrenière would be entirely absorbed. The space reserved for machines 19 and 20 had been placed at the disposal of the "Compagnie d'Industrie Electrique," to enable them to establish here a central station for alternating current supply, which station the town was to acquire at the end of 1895. On the other hand, the concession given to the gas company expired at the same time, and the town was going to take the gas service over. According to calculation, it would be necessary to substitute electric for gas lighting for the streets to a large extent; this change, taking into account the increased illumination, represented an additional expenditure of energy of 700 H.P. In order to satisfy the continually growing demand for electric street lighting, and in order to be ready for supplying the International Exhibition in 1896 in a satisfactory manner, it was necessary to construct a second Works very quickly. Already in 1882 the Administrative Council had considered the question, and reports had been drawn up and examined. They then applied to the State Council for a concession for a further part of the Rhône; after examining the matter, this body drew up the basis of a convention in 1885, reserving 25 per cent. of the net profits for the State after deducting 6 per cent. for interest and redemption of capital.

Finally, on October 21st, 1890, the Corporation, on the advice of the Administrative Council, passed a vote of 10,000 francs to defray the cost of studying various schemes. The investigation was carried out under the direction of M. Turrettini, Administrative Councillor, by the technical staff of the Hydraulic Service, and on April 29th, 1892, this gentleman presented to the Corporation a report supporting the application for a concession for the second Works.

During these 12 years the sale of water, and particularly of hydraulic power, had increased in a manner quite beyond the expectations of the most optimistic.

In 1880 the receipts were about 274,000 francs, and in 1892 these had reached over 658,000 francs. The hydraulic power receipts included in the above had, however, increased five times, whilst the annual cost of a horse-power had been reduced from 1,200 to 400 francs. The quantity of water raised in 1880 was 5,480,615 cubic metres, and this in 1892 had increased to 31,608,597 cubic metres.

The Schmid motors, generally in use in 1880, did not exceed 4 H.P.; after 1886 many turbines of various types were installed, of which the power reached 200 H.P. The capital employed in 1880, after deducting sinking fund, was 1,187,296 francs; in 1892 it reached 6,407,308 francs.

The net revenue from the water service, after deducting interest and sinking fund, and including the water used by the Corporation at its net cost, increased from 136,730 francs in 1880, to 183,958 francs in 1892.

The studies made by the Hydraulic Service comprised great numbers of measurements, and many observations and examinations of various sites. The available heads at five places were tabulated as follows:—

Location.	Normal high water metres.	Normal low water metres.
(*a*) Iles d'Aire	0·85	3·65
(*b*) Vernier Mill—		
1.—With tunnel ...	4·00	4·00
2.—Dam for high water	2·30	5·40
3.—Dam for low water	0·65	2·00
(*c*) Above Chèvres	4·40	7·95
(*d*) Below Chèvres	5·05	8·80
(*e*) Below Lagnon	6·35	10·40

Referring to the first location, the cost of the turbines under these conditions would have been greater than further down stream. Besides, in order to simplify the electrical machinery, it was desirable that the speed of the turbines should be at least 80 revolutions per minute in order to permit of direct coupling; but such a speed could not be obtained with these heads.

As regards the Vernier Mill, the estimated cost of the tunnel was 1,820,000 francs; this would have been reduced by building a dam, but then the head would have been reduced from 4 metres to 2·3 metres. It was, therefore, necessary to consider sites still further down stream. The following interesting table was compiled, showing the different powers which could be obtained at various heads with a turbine of similar type to those at Coulouvrenière, and for each example the net cost per H.P. It was assumed

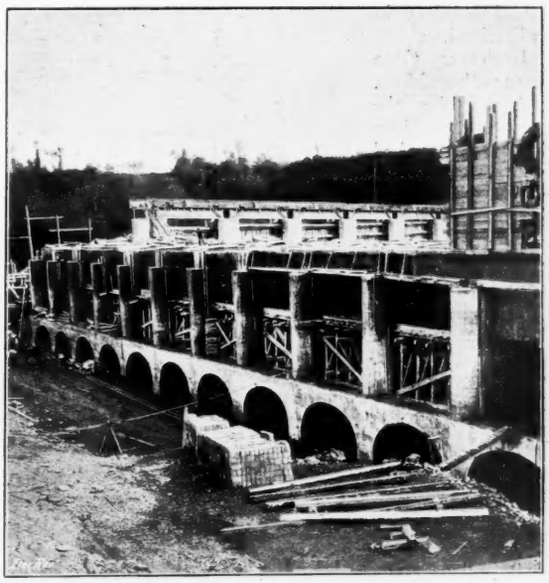
that the turbines would also cost the same amount as those at Coulouvrenière.

Head.	Flow.	Volume.	H.P.	B.H.P.	Revs.	Francs.
H	$\cdot 65\, r\sqrt{2gH}$	$3{\cdot}3976\, r = Q$	$\frac{Q\,H}{75}$	$\frac{Q\,H \times 0{\cdot}70}{75}$	$\frac{60\,v}{2{,}928}$	Per H.P.
Metres.	Metres.	Cub. metres.				
0·65	2·32	8·35	72·3	50·6	15·00	533.60
2·20	4·27	15·36	450·6	315·4	28·00	85.60
4·00	5·79	20·71	1104·00	772·8	37·5	35.00
5·00	6·44	23·16	1544·00	1080·00	42·00	25.00
6·00	7·05	25·37	2030·00	1421·00	46·00	19.00
7·00	7·62	27·40	2558·00	1790·00	50·00	15.10
8·00	8·14	29·30	3125·00	2187·09	53·00	12.30
9·00	8·64	31·08	3729·00	2610·00	56·00	10.40

Generating Station.

On comparing these two tables, it became apparent that the best place for the works, at a cost not too high, was situated about 600 metres below the Chèvres Mill. With 5 metres of normal head, the fall was sufficient to permit of direct coupling. With an adjustable weir the power at times of low water would be 120 cubic metres × 8·80 = 10,560 H.P.

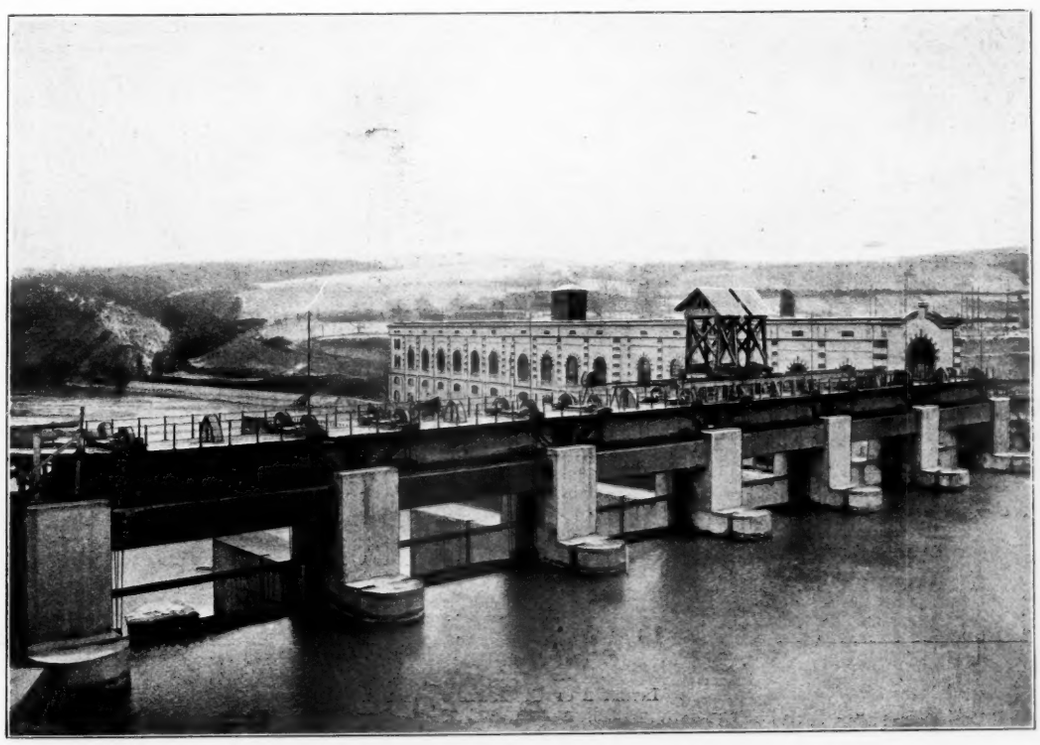
The site at Lagnon was discarded, because of the increased distance, and the extra cost of appropriation. A report was then drawn up, examined by an independent expert, and presented to the Corporation. Afterwards certain difficulties



Turbine-House in Course of Construction.

cropped up with reference to the dam, and it came to the knowledge of the Administrative Council that there were some large dams in England on the Stoney system—a system which had been adopted for those on the Manchester Ship Canal.

M. Turrettini, the president, and M. Butticaz, engineer of the Water Service, came to England to examine the system.



View of Weir and Generating Station.

The superiority of the Stoney method lies in the ease with which enormous gates can be manipulated with a limited staff of attendants. This is done by rotating the gates on movable rollers.

F

The only question to be decided was whether it was possible to construct a similar dam at Chèvres; the inventor, Mr. Stoney, wished to do the work himself, but on learning that the town was carrying out the undertaking, he arranged that the work should be done in Switzerland.

However, there was another hitch. Before voting the money, negotiations for purchase had been entered into with the owner of the land for the buildings and their surrounding—about 50 hectares. This person first asked 100,000 francs, then 80,000 francs, and the town offered 70,000 francs.

After the Bill had been passed, the negotiations were resumed, when it was found that the land had been sold. The town only required 6 hectares for the actual buildings, but the new landlord asked 75,000 francs for this. In consequence of this exorbitant demand a new site was chosen, 600 metres up-river, and opposite the Chèvres Mill.

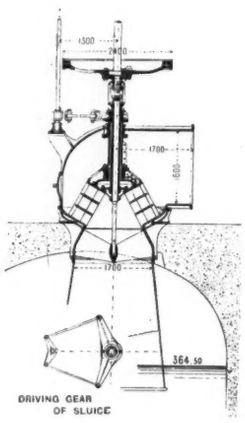


Fig. 3.—Exciter Turbine Cross Section. Dimensions in Millimetres.

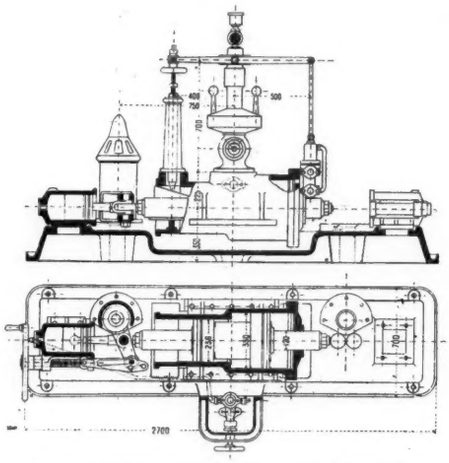


Fig. 2.—Regulator, Vertical and Horizontal Sections. Dimensions in Millimetres.

In 1893 the Corporation voted a credit of 3,000,000 francs for the first portion of the works. The programme of work comprised three sections:—

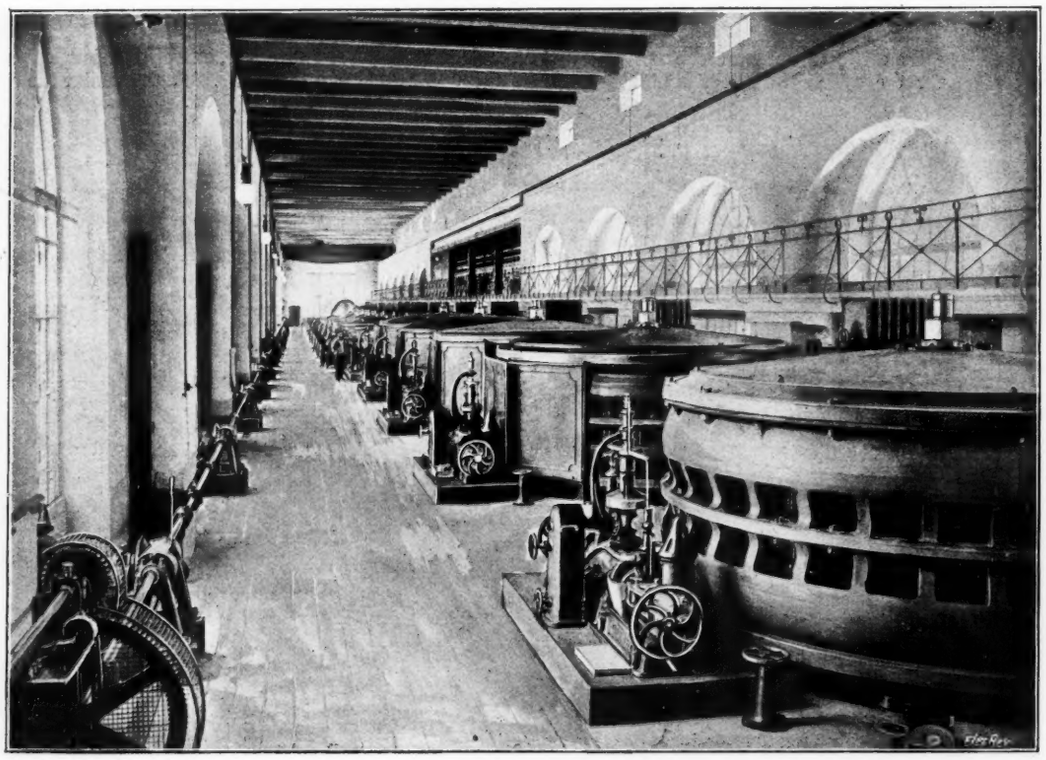
1. Construction of the dividing dike, the coffer-dams on the left shore, and the dam.

2. Construction of the coffer-dams on the right shore, the turbine buildings, and the head and tail races.

3. Erection of the machinery, and laying of the feeders.

First Undertaking, 1893.—The Dam.

The chief work of this undertaking was the construction of the dam, but it is unnecessary for the purposes of this article to deal at length with these operations. Taken as a whole, the dam consists of one inverted arch foundation, two abutment piers, five intermediate piers, having between them spaces for six gates, each with an opening of 10 metres, the said gates, and the gear for moving them. The draining-off went on for nearly a year. It was done partly by a Dumont pump of 10,000 litres capacity, worked by a portable engine, and partly by a pulsometer.



Interior of Generating Station.

Second Undertaking, 1894.—The Station.

The turbine building is 137 metres long. The foundations comprise 18 bays, 7·5 metres centre to centre, separated by piers of 1·5 metres thickness. This series of vaults is used for the following, beginning up stream :—

1. Oil pumps.
2. Exciters, oil pumps, and exciter turbines.
3. Oil reservoir, inflow and outflow channel.
4 to 18. Generators and their turbines.

The foundations comprise the following quantities :—15,712 cubic metres of concrete with various limes (200 kilos. per cubic metre): 97 cubic metres of cement concrete (400 kilos. per cubic metre); 1,784 cubic metres of ditto (200 kilos. per cubic metre)—or a total of 17,593 cubic metres. The building itself, at the down-stream end, comprises various offices, &c., and then follows the large machine room. A gallery for visitors runs the whole length of this room.

Third Undertaking, 1895.—The Machinery.

During the year 1895, the first three sets of generators and two sets of exciters were installed. Each of the generator sets, which have a minimum output of 1,000 H.P. each, consists of one large double turbine, and an alternator mounted on the same shaft. The exciter sets also consist of similar turbines with exciters, but their output is only 150 H.P. each.

The Turbines.

The duties which the turbines had to fulfil, according to the condition of the river, may be summarised as follows :—

1. Winter conditions, low water.—Net fall 8·50 metres. Output 1,200 H.P. (effective), with a volume of water as small as possible, yet at the maximum efficiency.
2. Summer conditions, high water. — Net fall 4·30 metres. Output 800 H.P. (effective), with an optional volume of water to the extent of 50 per cent. efficiency.
3. To maintain in every case, and under all conditions, a speed of 80 revolutions per minute, yet without it being necessary to have too large or too costly machinery.

The problem, therefore, presented two principal conditions for solution :—

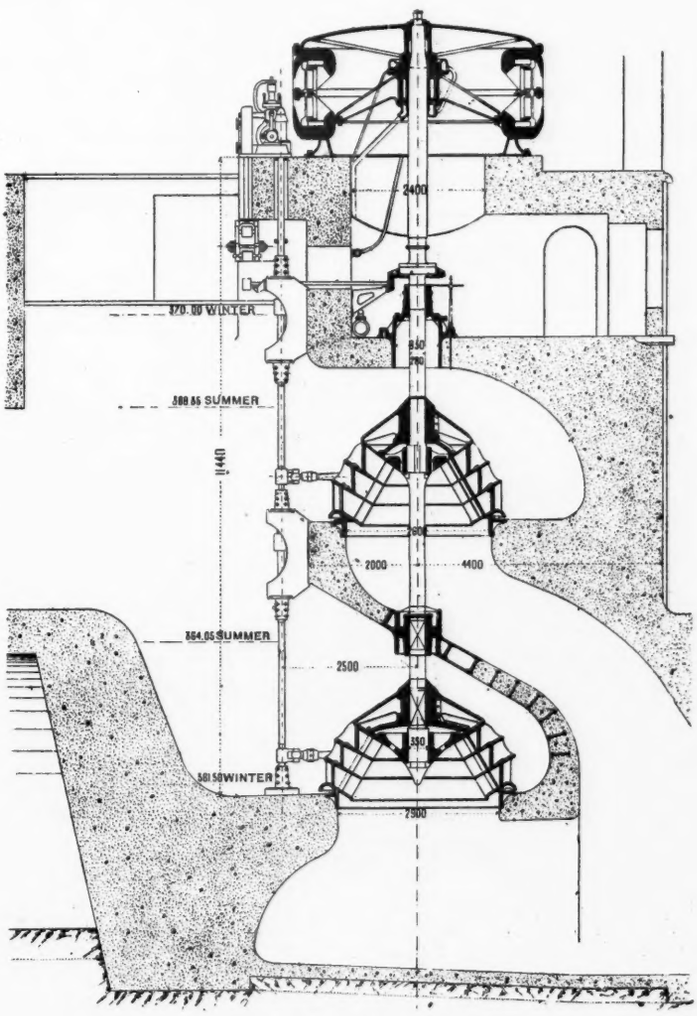
(*a*) To obtain a good output when the turbines were obliged to run with a partial admission on 50 per cent. of their blades, although it is the contrary effect which is generally realised.

(*b*) To attain a relatively very high speed considering the fall, its variable qualities, and the large horse-power required.

Two firms sent in schemes—Messrs. Faesch & Picard, of Geneva, and Messrs. Escher, Wyss & Co., of Zurich—that of the latter being adopted.

Sets 1 to 5.—The great importance which the variation of the fall assumed when the object aimed at was to obtain the highest possible number of revolutions with such large units, led to the adoption of double turbines, that is, of two turbines one above the other, on the same shaft (fig. 1).

The lower turbine is specially arranged for times of low water, when it drives by itself and develops 1,200 H.P. with the maximum fall of 8·50 metres.



Dimensions in millimetres; water level in metres.

Fig. 1.—Double Turbine and Generator, Cross Section.

The upper turbine, on the other hand, is for times of high water, and its dimensions are proportioned in such a way as to give, when running together with the lower turbine, 800 H.P. at the minimum fall of 4·30 metres. This double arrangement permits of maintaining continually, and under the two aforementioned conditions, a uniform speed of 80 revolutions per minute.

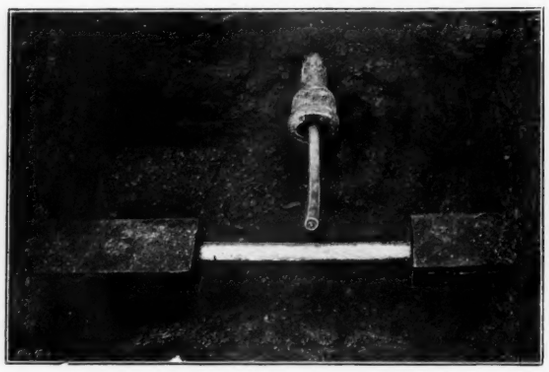
The two turbines are constructed on the principle of conical reactive turbines, patented by Escher, Wyss & Co., each one having three rows of blades, and the water being introduced through their upper part. The method of construction makes it possible to realise a relatively high number of revolutions despite the small height of the fall, and to obtain large channels of flow for the moving wheel as well as for the guide wheel.

After the water has passed the upper turbine, which runs partly with a suction head, it is conducted into an **S**-shaped channel made of concrete strengthened with **I**-beams and escapes into the tail race.

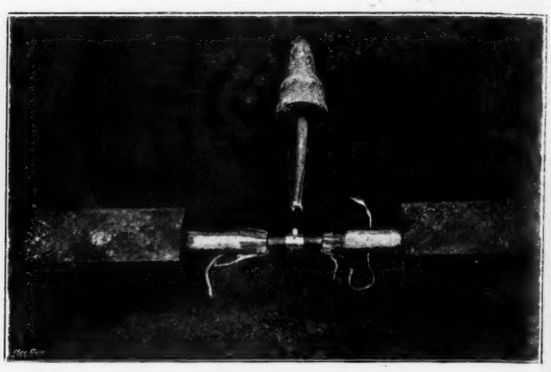
The lower turbine runs almost entirely by the pressure of the fall. The shaft, of massive steel, 0·3 metre diameter, is firmly supported by four bearings and coupled direct to the alternator shaft, at the upper end of which is a ring bearing specially constructed for forced lubrication.

The guide wheels have special kinds of blades, allowing of regulation by means of sub-divided sluice gates with an instantaneous circular movement, giving an exceptionally prompt regulation. Each of the two turbines has separate sluice gates, whose action controls the three rows of the guide wheel simultaneously, the orifices of which it opens or shuts with a movement having a relatively very small amplitude. Each of the sluices has its own regulating gear, arranged in

such a way that it is in direct connection with the automatic governor. The latter is placed at the side of the alternator and is operated from the turbine shaft by means of bevel



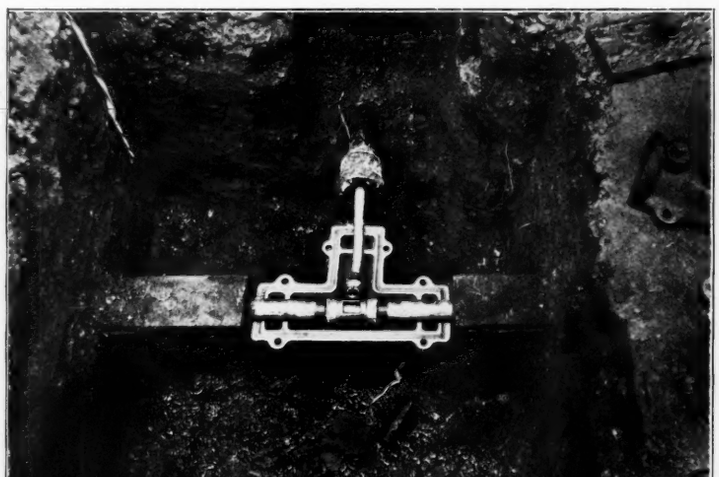
Record Joint Making.—Fig. 1.



Record Joint Making.—Fig. 2.

wheels and belts. The hydraulic regulating apparatus is worked by the governor, and operates, according to its position, by acting on one or other of the sluice gates. This movement, particularly at the time of starting, acts at first on the lower sluice gate; afterwards, when this is completely open, on the upper sluice gate, following automatically. At the commencement of stopping the same action takes place in inverse order.

The regulating apparatus (fig. 2) consists of three cylinders mounted on a common foundation. The two outer cylinders and the centre chamber of the differential cylinder are under a constant oil pressure of about 15 atmospheres, produced by a special pump which also feeds the ring bearing. The pressure in the large chamber of the cylinder is modified according to requirements by the governor by means of a regulating valve, which induces the motion in advance of or later than the piston valve.

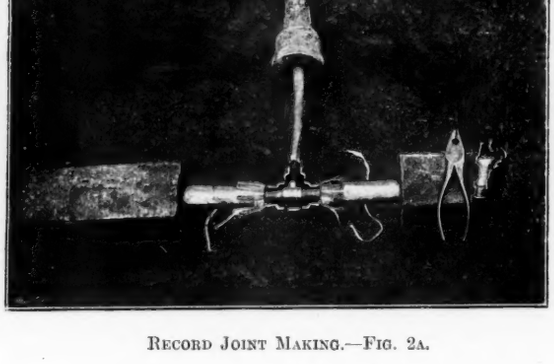


Record Joint Making.—Fig. 3.

The centrifugal governor is controlled by springs and works on knife edges under an oil jet, and its action by means of the regulating apparatus is very prompt. The balls and the regulating valve, as well as the piston valve, are connected together by means of a lever and link motion.

The operation of this regulating mechanism is so sensitive that the actual regulating devices—that is, the sluice gates—follow, as it were instantaneously, the movements of the balls as if they were connected directly to the governor, and, in fact, the regulation is most perfect despite the highly unfavourable conditions. The tests which were made gave the following results:— In the case of the sudden variation of the load by about 300 H.P., the number of revolutions were reduced momentarily by 3 per cent.; in the case of suddenly throwing off the full load from the two turbines the variation was from 3 per cent. to 5 per cent., and in the space of 4 to 5 seconds the governor had re-established normal speed.

The exciter turbines (fig. 3) are also conical turbines with



Record Joint Making.—Fig. 2a.

Record Joint Making.—Fig. 4.

is generally realised.

Each of the sluices has its own regulating gear, arranged in

three rows of blades, but with a closed chamber, a short conical adductor suction tube, and a hollow cast-iron shaft with an ordinary step bearing.

The regulating arrangement for these turbines consists also of a sub-divided sluice gate for the three rows of blades and of a governor, exactly similar to those of the large turbines.

(To be continued.)

RECORD BREAKING JOINT MAKING.

By L. ANDREWS, Borough Electrical Engineer, Hastings.

At the recent meeting of the Municipal Electrical Engineers at Huddersfield, Mr. Wilkinson, of Harrogate, in his paper on "The Distribution of Electricity," referred to the fact that a service joint box for a triple-concentric cable costs from £2 to £3 5s., and in the discussion on this paper, the writer mentioned that the Hastings Corporation had for some time been using a joint box which only cost £1, and that one jointer was able to connect on as many as eight or 10 services in a day. As several members expressed themselves anxious to know more about this joint, whereas others doubted the possibility of getting jointers to make satisfactory joints in so short a time, I have had a series of photos. taken, showing the entire process of connecting a concentric service on to a triple-concentric main.

Fig. 1 shows the service and main as it was left by the labourers ready for the jointer.

Fig. 2 is a photo. of the joint exactly 15 minutes after the jointer had commenced work upon it. It will be seen that 3 or 4 inches of the outer insulation has been cut away from both cables, the outer or neutral conductor of the triple has been cut and splayed back, about an inch of the insulation between the outer and intermediate conductors has also been cut away, and the inner conductor of the concentric service has been sweated on to the intermediate conductor.

Fig. 2A shows the joint in the same stage, except that one of the half clips, used for completing the outer or neutral circuit, has been placed in position. The clearance between the intermediate and outer conductors is here shown. This clearance is filled up when the joint is completed with melted wax or other highly insulating compound. The other half of the conducting clip is shown on the right-hand side of the pit in fig. 2A.

Fig. 3 shows the joint 12 minutes after the photo. shown by fig. 2A was taken. Here it will be seen the outer conductors of each of the cables have been bound and sweated on to the outer conducting clip, and the bottom half of the exterior cast-iron box has been placed in position.

The final photo., fig. 4, taken 6½ minutes later, shows the completed joint with the top half of the cast-iron box bolted into position, and the whole of the space inside the clips, and between the clips and the outer box, filled with melted wax.

The total time taken in making this particular joint, from start to finish, was just 33½ minutes. Is not this a record?

This joint box, which is the invention of Mr. J. Glass, mains foreman to the Hastings Corporation, has been exclusively used on the Hastings mains during the past 12 months. The insulation resistance of a completed joint is usually several hundred megohms, and it will stand a pressure of over 10,000 volts without showing any signs of breaking down. The conductivity of the cable is practically unaffected by a number of joints being taken off in a comparatively short length, as all the joints are soldered, added to which, where services can be taken off the intermediate and neutral conductors, the neutral conductor is the only one cut. The practice at Hastings is to joint small consumers' services on to the intermediate and neutral conductors, and large consumers on to the inner and neutral; by this means the system is balanced by about one inner connection to every four or five outer connections. The process of jointing a service on to the inner conductor is practically the same as that shown by the photographs, the only difference being that an additional pair of half clips are used for connecting up the intermediate conductor, which, in this case, has to be cut asunder to enable the inner conductor of the concentric to be jointed on to the inner of the triple.

As the completed joint takes up very much less room than an ordinary joint box, a joint can be made in positions where it would be quite impossible to use an ordinary joint box.

It will be noted that the clearance between the conductors is not in any way dependent upon the skill of the jointer, but is fixed by the branches of the clips resting on the insulation of the cables. These clips are drilled out to fit cables for which they are intended to be used.

There are many other useful points about this joint, which will be apparent to those using it.

TELEGRAPH AND TELEPHONE NOTES.

(Continued from page 585.)

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
South American:—		
Pará-Maranham	March 1, 1900	
Ceará-Maranham	Feb. 20, 1900	
Paramaribo-Cayenne	Oct. 6, 1900	
West Indies:—		
Mole St. Nicholas-Cape Haitien	March 6, 1900	
Latakia-Cyprus	June 20, 1899	
St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
Tarifa-Tangier	Jan. 2, 1900	
Zanzibar-Mombassa	Sept. 29, 1900	
Landlines:—		
Chinese:—		
Tientsin-Pekin	June 12, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 20, 1900	
Tientsin, *viâ* Shanghai	June 16, 1900	
Tientsin-Niuchwang	June 18, 1900	
South American:—		
Communications with all offices of Columbia beyond Buenaventura	January 22, 1900	
Ecuador landlines	March 18, 1897	
Landlines south of Serena	July 30, 1900	
Communication "*viâ* Hanekins" interrupted on Persian territory	Feb. 24, 1900	
Paramaribo-Cayenne	Oct. 6, 1900	
All Hayti landlines	Oct. 9, 1900	

Glasgow Telephones.—At the last meeting of the Corporation Mr. Alexander, in moving the adoption of the telephone minutes, said that while the work of erecting the telephone system had been delayed by the difficulty of obtaining materials from the contractors, they were now getting on satisfactorily. The committee hoped to make a start at the end of this year. They had already got 3,600 *bonâ fide* subscribers.

The Mexican Cables.—The Western Union Telegraph Company announces the complete restoration of telegraphic communication *viâ* Galveston, with Mexico and Central and South America. The damage to cables and land wires near Galveston and throughout the United States, caused by the hurricane on the 10th ult. has, it is added, made it impossible to sooner restore reliable communication.

New U.S. Cable Ship.—A New York exchange says that the U.S. army transport *Burnside* has been recently fitted out at the Morse Ironworks, Brooklyn, N.Y., as a cable ship for the exclusive use of the Government. She is preparing to sail soon with a deep-sea cable to be laid in the Philippines. The *Burnside* has been completely overhauled, and all the necessary cable appliances have been installed. Three large cable tanks have been built in her hold, each about 25 feet in diameter and 15 feet deep. Each tank has a capacity for 250 miles of cable. The cable will be laid under the supervision of Capt. Squier, of the Signal Corps. The *Burnside* was formerly the *Rita*, one of the prize steamers captured from Spain during the late war. The *Burnside* will take the place of the cable ship *Hooker*, which was wrecked on Corregidor Reef, near Manila, some time ago.

Portsmouth Telephones.—The promoters of the Municipal Telephone Exchange, for which a license has been sought, are much encouraged by the number of applications for instruments which have been received. At the end of last week these totalled up to over 500. The Fareham urban authority, at a meeting on Friday, in answer to a letter from the town clerk of Portsmouth, decided to support the telephone exchange about to be established, on condition that the Fareham authority retained control of the roads under its jurisdiction.

Submarine Telegraphs in South America.—The New York *Electrical Review* says that United States Consul Edwin N. Gunsaulus writes from Pernambuco, Brazil, as follows:—"The city now takes first rank as a cable station in South America, and has lately made material improvements in its submarine telegraphic service. It has no less than 10 cable lines to various parts of the world. There were formerly three cable companies here, but recently two of them were consolidated. The present companies are the Western Telegraph Company, Limited (English), and the South

later than the piston valve.

The exciter turbines (fig. 3) are also conical turbines with

American Cable Company. The first named has a very complete system, and is now finishing two or three lines to Brazilian ports. One of these is a through line to Para, another to Para touching local points, and still another to Rio de Janeiro. It now has distinct lines running to Para, Ceara, Rio and Bahia; two to St. Vincent, Cape Verde Islands, and one to Europe *vid* Lisbon, Portugal. Several of these cables are duplexed, while another line to Rio will be triplicated to Monte Video. These lines are constructed according to the latest scientific improvements, and some of them have a carrying capacity of 200 letters a minute. The rate for messages from here to New York *vid* Europe is about $1.15 per word. The Western Company has 50 people constantly employed here as an office force. The South American cable line touches several South American points, going thence to the Canary Islands, Cadiz, Spain, and Africa."

Wireless Telegraphy in 1876.—*L'Electricien* prints the following extract from a copy of *La Liberté* dating as far back as 1876:—"M. Loomis (an eminent American meteorologist) has been making some very curious experiments in the Rocky Mountains. He has succeeded in transmitting signals by the aid of two kites, the strings of which contained a conducting wire, and which were several miles apart. The signals were transmitted and received by the aid of Morse instruments. M. Loomis will probably continue his experiments in Europe."

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—October 17th. The Tramways Committee wants tenders for 25 electric tramcars, and electrical equipments for six horse cars. See "Official Notices" September 21st.

Balearic Islands (Spain).—October 30th. The municipal authorities of Palma (Balearic Islands), are inviting tenders until the 30th inst., for the electric lighting of the public streets of the town, by means of 60 arc lamps. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamento de Palma (Balearic Islands).

Belfast.—November 23rd. Tenders are invited for steam pipes, pumps, condensing plant, boilers, mechanical stokers, superheaters, coal and ash conveying plant, and switchboard extensions for the Corporation electricity works. See "Official Notices" to-day.

Bermondsey.—October 15th. The Vestry wants tenders for steam and other piping, feed pumps, tank and ironwork; also steam dynamos, battery charging motor booster and balancer. See "Official Notices" September 28th.

Bootle.—October 13th. The Corporation wants tenders for a steam dynamo. See "Official Notices" September 28th.

Budapest.—October 15th. The Hungarian Minister of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" August 3rd.

Bradford.—October 25th. The Corporation wants tenders for a 30-ton electric travelling crane for the new electricity works. See "Official Notices" to-day.

Bulgaria.—October 15th. The municipal authorities of Varna are inviting tenders until October 15th for the concession for the electric lighting of the town during a period of 40 years.

Bulgaria.—October 22nd. Tenders are invited by the Municipality of Philippopolis for a concession for electric lighting and a tramway in that town.

Cardiff.—October 23rd.—The Corporation wants tenders for slow speed vertical engines and generators; also boilers, economisers, &c., for electric tramways. See "Official Notices" October 5th.

Cuba.—October 26th. The municipality of Cienfuegos is inviting tenders for a service of public electric lighting for the town. All inquiries and tenders to be sent to the Secretary's Office in Cienfuegos, Cuba.

Dundee.—October 15th. The Gas Commissioners want tenders for the supply and erection of three steel water tanks at the electric lighting station. Form of tender, &c., may be had on application to Walter H. Tittensor, city electrical engineer, Dudhope Cresent Road, on deposit of £1 1s.

France.—October 18th. Tenders are being invited until the 18 inst., by the French Post and Telegraph authorities in Paris, for the supply of 85,000 porcelain insulators in nine lots. Tenders are to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris, whence particulars may be obtained.

Glasgow.—October 13th. The Corporation wants tenders for cables for connecting up plant, also for transformers connecting bars, at the Pinkston power station. See "Official Notices" October 5th.

Great Western Railway.—October 22nd. Tenders are required for the supply of stores (from December 1st, 1900, to November 30th, 1901), including telegraph poles, apparatus and accessories, electric light carbons, lamps, &c. See "Official Notices" October 5th.

India.—October 16th. The Secretary of State for India in Council is prepared to receive tenders from such persons as may be willing to supply (1) a complete electrical installation for supplying power to a factory from a waterfall (about 3 miles distant from factory). The generator will be required to develop about 500 KW., and the installation is to include complete plant of generators line, transformers, cables, motors, &c. (2) a complete hydraulic installation required to develop about 500 H.P. from a waterfall approximately 620 feet high. The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office on Tuesday, October 16th, 1900, after which time no tender will be received. (E. Grant Burls, Director-General of Stores.)

Lincoln.—November 15th. The Corporation wants tenders for a dryback marine-type boiler; a high speed engine coupled to a C.C. dynamo; pump and motor and accessories.

London.—November 10th. The Streets Committee of the Corporation wants to hire a mechanically driven dust cart. See "Official Notices" October 5th.

London, N.E.—The Acme Wood Flooring Company wants tenders for the electric wiring of its mill premises at Victoria Park. See "Official Notices" to-day.

Maidstone.—October 16th. The Corporation wants tenders for surface condenser and feed pumps. See "Official Notices" September 28th.

Stavanger.—January 2nd. Tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by January 2nd, 1901. Further information may be obtained on application direct to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Sunderland.—October 15th. The Corporation wants tenders for 24 car bodies, trucks, and electrical equipments. See "Official Notices" September 28th.

Warrington.—The Corporation wants tenders for the installation of electric light mains and fittings into the electric station and central sanitary depôt. See "Official Notices" September 28th.

Whitechapel.—October 23rd. The Board of Works wants tenders for an overhead traveller (hand driven) for the electricity works. See "Official Notices" October 5th.

Whitehaven.—October 13th. Tenders are wanted for the supply and erection of a switchboard at the electric lighting station. See "Official Notices" September 14th.

CLOSED.

Barrow-in-Furness.—The Corporation have placed the contract for a year's supply of motors for hiring out purposes from 1 to 10-H.P. with Messrs. D. Bruce Peebles & Co.

Epsom.—The contract for the electric light installation (wiring and fitting) at the Horton Asylum, Epsom, has been given to F. Troy & Co., of Finchley Road, N.W.

Halifax.—The Tramways Committee has given a contract to the Lorraine Steel Company, for 2,000 tons of tramway rails, at £7 per ton, with the necessary fishplates at £8 per ton.

Newport.—The Board of Guardians have accepted the tender of Messrs. Gilbert J. Lloyd & Co., of Bristol, at £1,560, for the electric light installation at the new workhouse.

Stockport.—The Council at their last meeting accepted the recommendation of the Electric Tramways Committee that the tender of Messrs. Dick, Kerr & Co., Limited, for 20 top-seat cars at £675 each, be accepted.

The War Office.—We understand that the War Office have accepted Messrs. Pritchetts & Gold's tender for supplying and fixing a battery and stands, for each of the Spithead Forts. There will be 33 cells at the Spitbank Fort, and 44 at both Horsesand and Noman's Land Forts, and in all cases the boxes will be of teak lead-lined.

Wolverhampton.—The Corporation have accepted the following tenders for extensions at the generating stations:—Messrs. G. & J. Weir, Glasgow, three direct-acting feed pumps at £280 10s.; Messrs. T. Bridges & Sons, Wolverhampton, for the supply, delivery and erection of steam exhaust and suction piping at £150; and Messrs. H. Willcock & Co., Wolverhampton, for the building of concrete foundations for the new engines, and construction of new floor and pipe trench, £625.

Worksop.—The order for the supply, delivery, and erection of the steam dynamos, balancers and boosters for the new electricity works, has just been placed with Messrs. Witting Bros., Limited. The engines will be of the Scott & Mountain type, direct coupled to Messrs. Witting's standard multipolar dynamos.

pair of half cups are used for connecting up the intermediate

FORTHCOMING EVENTS.

Friday, October 12th. — Electro-Harmonic Society's Smoking Concert at St. James's Hall Restaurant.

Friday, October 26th.—At 5 p.m. Physical Society Meeting:—(1) "Exhibition of Experiments Illustrating Certain Phenomena of Vision." By Dr. Shelford Bidwell, F.R.S. (2) "On the Concentration at the Electrode in a Solution, with Special Reference to the Liberation of Hydrogen by the Electrolysis of a Mixture of Copper Sulphate and Sulphuric Acid." By Dr. J. S. Sand. (3) "Electromotive Force and Osmotic Pressure." By Dr. R. A. Lehfeldt.

Thursday, November 8th.—Institution of Electrical Engineers. Opening meeting for the new session, when Prof. John Perry will deliver his inaugural address. Presentation of premiums.

NOTES.

The Electric Furnace.—*Engineering* has a note on a paper read before the International Electricity Congress at Paris, in which M. Keller took up the subject of electric furnaces. These he divides into three types. In the first of these the heating is effected by an arc, as in the original Siemens furnace, and in the laboratory furnaces so skilfully used by M. Henri Moissan. In the second class come the resistance furnaces, such as used by Heroult; whilst in the third are incandescence or multiple arc furnaces, as introduced by Cowles. The furnaces of the second type are said to be the best adapted for the production of carbide, as, though heavier currents are needed than with arc furnaces, fusion is effected quietly, and there is no very violent evolution of gas. In these furnaces the charge itself acts as a conductor for the current between the electrodes. Alternating currents are now very largely used for working electric furnaces. The size of these furnaces is at present limited by the difficulty of obtaining carbons of sufficient size for the electrodes. As matters stand, some furnaces take currents of 10,000 amperes, and require carbons of corresponding size.

The same contemporary refers to a note published in the *Chemical News*, in which Mr. C. S. Bradley describes the production in the electric furnace of the silicides of calcium, strontium and barium. The compounds are produced by mixing together powdered sand and the oxides of the above metals with sufficient carbon to take up the oxygen present, and the mixture is then subjected to the heat of the electric furnace. The compounds in question decompose when placed in water, the products of the reaction being the oxides of the alkaline metals, silica and pure hydrogen. The amount of hydrogen liberated is very considerable, 1 lb. of $Ca\,Si_2$ producing ·104 lb., or 18·73 cubic feet of hydrogen, and this reaction may, perhaps, prove useful industrially. The calcium silicide, when treated with dilute acids, produces the compound $Si_2\,H_2$, analogous to acetylene which has the formula $C_2\,H_2$. This silicon acetylene is a yellow solid, perfectly stable at ordinary temperatures, but oxidising when heated in the open air, and yielding hydrogen when treated with a 20 per cent. solution of caustic potash or caustic soda. It is anticipated that these silicides may prove useful in the dye industries, as they are very powerful reducing agents and can be produced at a low cost in places where electric power is cheap.

City and Guilds of London Central Technical College.—The Old Students' Association of the College held its third annual dinner on Tuesday, October 2nd, at the Restaurant Frascati, Prof. O. Henrici, LL.D., F.R.S., Dean of the College and President of the Association, taking the chair. Among those present were the Professors of the College, Sir A. R. Binnie, who had in the afternoon given the inaugural address at the opening of the College session, and Mr. A. L. Soper, assistant secretary to the Institute, in addition to a large number of old students.

Institution of Electrical Engineers. — We are informed that the first meeting of the new Session of the Institution of Electrical Engineers will be held in the rooms of the Institution of Civil Engineers, at 8 p.m., on Thursday, November 8th, when the premiums for the Session 1899-1900 will be presented, and the President, Prof. John Perry, M.E., D.Sc., F.R.S., will deliver his inaugural address.

Educational Notes.—The Calendar of the Glasgow and West of Scotland Technical College for 1900-1901 sets forth the usual comprehensive courses of studies, arranged to fill the wants of all manner of students. This is one of our earliest and most efficient technical colleges; the scientific institutions upon which it is based date, in some cases, from the last century, and have earned a reputation as wide as it is merited. Amongst the regular courses laid down in the Calendar we note that of "chemical engineering," which seems a singular appellation until the subjects with which it deals are inquired into, when its use is fully justified. The electrical engineering curriculum embraces a wide field of work, both in lecture courses and in the laboratories. The composition of the syllabus might, perhaps, be improved. For example, the words "polyphase" and "multiphase" occur in consecutive lines more than once. Why use the latter at all? A large number of bursaries and scholarships are offered, and special facilities for obtaining the degrees of B.Sc. and D.Sc. in engineering of Glasgow University are placed at the disposal of students of the Technical College. Prof. Magnus Maclean, M.A., D.Sc., late of Glasgow University, is the head of the department.

The new municipal technical school of the Manchester City Council plunges at once *in medias res* with an imposing syllabus of 360 pages. The volume is in itself a step in advance, embodying excellent views of the school and of the various departments thereof, as well as of artistic designs and models executed by students of the art schools. Various courses of instruction are drawn up, suitable for the requirements of all classes, and are explained at considerable length. The electrical engineering department is exceptionally well equipped with up-to-date machinery and appliances, and a very practical syllabus of lectures and laboratory work has been drawn up, covering a wide field of electrical technology. The department has been placed in the charge of Dr. J. T. Nicolson, D.Sc., who previously held a Canadian appointment, and Mr. W. W. H. Gee, B.Sc., formerly of the Victoria University.

Obituary.—We have to announce the death of Mr. John E. Hudson, President of the American Bell Telephone Company, which occurred with terrible suddenness on the morning of October 1st whilst waiting on the station for a train to Boston. John Elbridge Hudson was born in Lynn, Mass., August 3rd, 1839. He graduated at Harvard with the highest honours in 1862. Originally general counsel of the American Bell Telephone Company, he was subsequently appointed general manager, and in 1887 became Vice-President, and later President. Before his appointment to the highest office, it was generally assumed that Mr. Hudson had a large share in directing the policy of his company. He was a man of much culture, imposing appearance, and great personal charm, directing the great business under his charge with remarkable suavity. He was a lineal descendant of the Thomas Hudson who came over from England in 1630, and when opportunity offered, he often sought in rural England relaxation from the cares of his great business.

We regret to hear of the death of Mr. W. Butler, J.P., the chairman of the enterprising Bristol Tramways and Carriage Company. Mr. Butler, who had occupied that position since the company's inception in 1874, died on Saturday last in his 81st year.

Electricity in Coal Mines.—The system of electric mine haulage now universally adopted at Wimber, in the United States, has, says *Engineering*, greatly increased the output of the Eureka mines. Operations have been greatly expedited, and the cost of haulage has been decreased. In the case of one mine, the work was first developed by mule haulage in the cross headings, combined with a rope hoist in the main headings, the entrance to this mine having a dip of 2·5 per cent. for 3,000 feet. With this system, using eight mules and eight drivers in addition to the hoist, the daily output of the mine was 200 tons, at a cost of 83s., or about 5d. per ton. Using two electric mine locomotives in place of the mules and hoist, the daily output has increased to 1,000 tons, at a cost of 33s., or less than 0·4d. per ton.

Personal.—Mr. Geo. Marshall Harriss, who has resigned the position of electrical engineer to the Bray Council, is joining Prof. George Forbes as his chief assistant in Ireland. He will act as the resident engineer at Carlow taking charge of the electricity works there, which are now becoming an important undertaking. When the resignation came before the Council, Mr. Harriss was requested to reconsider his decision, but this he was unable to do. The Council accordingly accepted the resignation with regret, and decided to advertise for an engineer at a commencing salary of £150 per annum.

Mr. Charles Esson has retired from the position of works manager in the electrical department of Messrs. Johnson and Phillips at Old Charlton. His friends and the workmen in his department entertained him to dinner at East Greenwich last Friday week, and presented him with a silver smoking set, a silver mounted flask, and Mrs. Esson was the recipient of a gold brooch.

We read in the *Electrical World* that Mr. George G. Ward, the vice-president of the Commercial Cable Company, of New York City, has had the order of the Crown of the Second Class conferred on him by Emperor William of Germany. "The recipient of the honour is an Englishman by birth and an American of long adoption."

Mr. Angus, the chief assistant at the Bolton electricity works, has left to take up the borough electrical engineership at Eccles. The staff last week presented him with a silver cigarette case suitably engraved.

The First Commissioner of Works has appointed Mr. William H. Massey, M.Inst.C.E., consulting electrical engineer to Her Majesty's Office of Works for the Royal Palaces and public buildings in charge of the department.

Interruption of Railway Telegraph Signalling Apparatus through Leakage.—The Corporation of Stirling, whose supply works are only a few yards from the main line of the Caledonian Railway, and within a stone-throw of one of their signal cabins, have been somewhat concerned of late on account of fugitive current interfering with the telegraph and telephone signalling apparatus of the railway company. After making full inquiry, the Corporation informed the railway company that they had taken every precaution to prevent the cause of complaint, but they could not be held responsible for the disturbances. They asked, without prejudice to their legal position, what the probable cost would be of putting in an insulated return to prevent what was complained of. The railway company replied that they had a large number of telegraph, telephone, and other circuits terminated on earth in the Stirling area, and if leakages should be troublesome it might be necessary to provide return wires for them, or rearrange and terminate them elsewhere. In the meantime, however, the block telegraph circuits must be protected by return wires, and the cost of providing these would be about £30, and of maintaining them about £4 per annum. Mr. Bernard M. Jenkin, on behalf of Prof. Kennedy, the Corporation's engineer, writing to the Corporation on the subject, said that there was a decision given by Mr. Justice Kekewich, in an action brought by the National Telephone Company against the Leeds Tramways, which bore on the case. That decision had never been appealed against, and it held practically that the Telephone Company could not claim any right to the use of the earth as a return beyond what could be claimed by the tramway company or anyone else, and that if their telephones were interfered with by currents in the earth, they must protect themselves by using insulated returns. The Westminster Electric Supply Company, Mr. Jenkin also pointed out, had had demands from the railway companies, similar to that which the Corporation of Stirling had received, but the Westminster Company had refused to agree to pay for any such work, and all claims had now been dropped. In the light of this information, the Corporation instructed the clerk to reply to the railway company that they must protect themselves against interference with their telephone or telegraph lines by the use of insulated returns, if they find that they cannot use the earth satisfactorily, but that the Corporation would do all in their power to prevent the causes of complaint.

Mr. Punch and Electric Traction.—Even Mr. Punch is opposed to electric traction in the Lake District, for in his current issue he shakes his finger at the British Electric Traction Company thus :—

A WORD IN SEASON.

[The Lake District is to be spared the infliction of the Electric Tram.]

(*With apologies to the late Laureate*).

The Lake District (*loq.*)

Traction electrical and new,
Of me you shall not win renown.
You thought to break my country's heart
In preference to wooing Town.
At me you smiled, but unbeguiled,
I saw the snare and I retired:
The city's fit concomitant,
You're not by me to be desired.

Traction electrical and new,
I know you proud to bear your name;
Your pride is yet no mate for mine,
Which understands from whence I came.
Nor would I break for your swift sake
A heart that lives where Nature grows;
My simple Lake of Windermere
Is worth a hundred dynamos.

Traction electrical and new,
If time be heavy on your hands
Do you run through from Bow to Kew?
Has London made no more demands?
Oh, teach the City clerk to bless
You, as he's carried to and fro;
Attend to pressing business
And let this lovely district go!

Mr. Punch is not always correct. We thought he was old enough to know that electric traction would have wrought wonders from Bow to Kew years ago but for the opposition of the L.C.C. and others, who thought they were acting in the peoples' interests by trampling private enterprise under foot.

Fatality on the Central London Railway.—A fatal accident occurred on the new Central London Railway last Saturday afternoon. It seems that when one of the down trains arrived at Marble Arch station shortly after 2 o'clock it was discovered that one of the conductors, named Field, was missing. It is usual for these officials after they have called out the name of the next station and closed the doors to stand outside the doors of the cars, and it was thought that he might have been left behind at Bond Street station. A telephonic message to Bond Street elicited that this was not the fact, however, and the down trains having been stopped, the tunnel through which the train had just passed was searched, and the body of the unfortunate man was discovered, much injured, lying across the rails. He was at once taken to St. Mary's Hospital, where it was found that life was extinct.

At the inquest held on Wednesday at Paddington, evidence was given by George Tucker, the police inspector of the Central London, who said that he believed that Field came to his death by opening the gate to look in at the window of the car, to see if a certain passenger was smoking in a non-smoking compartment. His head, in being drawn back, must have struck against one of the lamps projecting from the side of the tunnel. Hair was found on a lamp, and the deceased's cap was discovered lying only about 8 feet away. It was against the regulations to open the gate whilst the train was in the tunnel. Before this accident occurred it had been arranged that the ends of the cars should be fitted with glass panels, and one train so fitted had started that very day. The other cars were being fitted with glass panels as quickly as possible, so that the conductors would be able to see into the cars from the platforms at the end. The jury returned a verdict of "Accidental death."

Appointments Vacant.—The Bray District Council is this week advertising for a resident electrical engineer at £150 per annum. A shift engineer at £100 a year is wanted for the Leyton electricity works. A resident electrical engineer is required by the Worthing Corporation at £250 per annum. See "Official Notices" to-day.

as time goes on, but we very much question if it will be considered to have been the best policy to adopt a flat rate for charging

The accounts of the electric lighting under-

Meter Testing in the City.—At yesterday's meeting of the Court of Common Council, the Streets Committee presented a scheme for the testing in future of all electric meters within the City, under the direction of the electric inspector, at the expense of the City of London Electric Lighting Company and the Charing Cross and Strand Electricity Supply Corporation, each company to contribute, in addition to the other expenses, £200 per annum to the Corporation in respect of the electrical inspector's salary. Under these circumstances, says the *City Press*, it is proposed that the inspector's salary should be increased from £350 to £500 per annum. Under the scheme the Corporation will be relieved in future of all expenses connected with the appointment, which expenses at present amount to £350 per annum.

The Pacific Cable Contracts.—The *Sydney Daily Telegraph* for August 30th published the following important item:—"It was announced the other day that tenders for the construction of the Pacific cable had been opened in London, the lowest tender being from the Telegraph Construction and Maintenance Company, Limited, which offered to do the work for £1,886,000, and to finish the construction of the cable within 18 months of the signing of the contract. The Postmaster-General was seen about the matter yesterday. He said: 'I am going to advise that the lowest tender be accepted, and that the work be put in hand at the earliest possible opportunity. The tender is not greater than the amount of the estimated cost. I thought it would have been much heavier.'"

Tests of Electrical Vehicles.—The secretary of the Automobile Club, 4, Whitehall Court, S.W., has sent to us a preliminary memorandum concerning the trials of electrical vehicles which are to be held from Monday, November 5th, to Friday, November 9th. Vehicles must be entered on or before Friday, November 2nd. The entry fee is two guineas per vehicle per trial. Forms of entry may be obtained after to-day, Friday. Vehicles entered may be subjected to the following trials:—

Monday, November 5th.—A run over a given course for an unlimited distance on one charge. The driver to declare to the observer when the run is to be considered as finished.

Tuesday, November 6th.—A course of 30 miles, to include considerable gradients.

Wednesday, November 7th.—A course of 30 miles of average road.

Thursday, November 8th.—A course of 30 miles of flat, or nearly flat, road.

Vehicles may be entered on or before Friday, November 2nd, for an additional optional trial, viz., on Friday, November 9th, as follows:—A run over a given course for an unlimited distance on one charge. The driver to declare to the observer when the run is to be considered as finished.

The same batteries will be used throughout, and during the course of the trials will be under the supervision of the club. Competitors are responsible for the supervision of the charging of their batteries.

The energy consumed, number of passengers carried, and average speed attained, will be recorded on certificates which will be granted by the club to competitors, but no speed in excess of the legal limit of 12 m.p.h. will be recorded or recognised. Competitors must supply drivers for their vehicles, and must provide on each vehicle a seat for an official observer. The routes on which the trials will take place will be within 50 miles of London, but will not be made known to competitors until immediately before the trials. Competitors are required to fit to their vehicles reliable and accurate voltmeters and ammeters which can be read during the trials by the observers, and these meters must be fitted with terminals by means of which they may be tested by the judges. In entering vehicles, competitors are requested to kindly supply, for the information of the judges only, a diagram of the electrical connections of each vehicle. A competitor, by entering a vehicle, thereby agrees to be bound by the rules and decisions of the judges' committee in all matters, and the judges' committee reserves to itself the right to amend the rules affecting the trials.

Coal for Electrical Generating Stations.—At a meeting of the South Wales Institute of Engineers held at Cardiff on Monday, Mr. Sydney Walker commented on the fact that within the past 12 months there had been a tendency to substitute inferior coals for the best Welsh steam coal in electrical generating stations. Up to within a few months ago Welsh coal was the most economical to use, but, owing to its recent high prices, other coals were being found more economical. Empirical experiment was expensive, and he trusted that soon a scale would be drawn up by which an engineer could discover at a glance which coal would produce the best results at a given price. The three chief points to consider were the possible heat units, the heat units wasted in ash, &c., and the price.

NEW COMPANIES REGISTERED.

Walker & Hodgetts, Limited.—This company was registered on September 27th, with a capital of £5,000 in £1 shares, to carry on the business of electrical engineers, electricians, mechanical engineers, iron, steel, and metal merchants, iron and brassfounders, makers of electrical and other engines, motors and machines, &c., and in particular to take over the business of electrical engineers and electricians carried on at Salford, Lancs., by E. O. Walker and W. B. Hodgetts. The first subscribers (each with one share) are:—A. Tongue, Ash Lea, Seedley, Manchester, F.C.A.; Miss E. Walker, 10, Wright Street, Chorlton-on-Medlock, Manchester; W. B. Hodgetts, 28, Mulgrave Street, Lower Broughton, Manchester; F. A. Moershell, Imperial Hotel, Malvern, Worcester, hotel proprietor; E. O. Walker, 10, Wright Street, Chorlton-on-Medlock, Manchester, electrical engineer; P. B. Tongue, Ash Lea, Seedley, Manchester, articled clerk; and Mrs. A. Walker, 10, Wright Street, Chorlton-on-Medlock, Manchester. The number of directors is not to be less than two nor more than six; the first are Frederick A. Moershell, Alfred Tongue (chairman), Ernest O. Walker, and Walter B. Hodgetts; qualification, £100. Registered office, 23, St. Simon Street, Salford, Lancashire.

Electric Railways Company, Limited (67,346).—This company was registered on October 1st, with a capital of £75,000 in £1 shares, to adopt an agreement with W. Shawe, to acquire any rights relating to railways, tramways, electric lighting, or other electrical installations, the supply of electricity for any purposes, or other public works and conveniences, and to carry on the business of electricians, engineers, founders, railway and general contractors, promoters, financiers, &c. The first subscribers (each with one share) are:—T. Everett, 20, Bucklersbury, E.C., clerk; P. J. May, 39, Basnett Road, Lavender Hill, S.W., clerk; T. Hunter, Dormans Land, East Grinstead, accountant; W. Smallbow, 34, Great St. Helens, E.C., gentleman; M. A. Bachman, 1, Austin Friars, E.C., gentleman; E. T. Robinson, 419, Strand, W.C., clerk; and C. Everett, 26, Rochester Square, N.W., book-keeper. The number of directors is not to be less than four nor more than twelve. The subscribers are to appoint the first; remuneration, £300 each per annum and £200 extra for the chairman.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Crompton & Co., Limited (27,200).—This company's annual return was filed on August 24th, when the entire capital of £162,000 in £3 shares had been taken up; £3 has been called up on each of 52,000 shares, resulting in the receipt of £155,736; £264 remains in arrears; £6,000 is considered as paid on 2,000 shares.

Bickle & Co., Limited (36,429).—This company's annual return was filed on September 10th, when 2,027 shares were taken up out of a nominal capital of £50,000 in 5,000 shares of £10 each; £10 per share has been called up on 1,027, resulting in the receipt of £10,220, and £50 remains in arrears; £3 has, in addition, been paid on three forfeited shares; £10,000 is considered as paid on 1,000 shares.

SUPPLY STATION ACCOUNTS.

Stockport Corporation Electricity Accounts.

The supply of electrical energy was commenced on December 9th, 1898, by the Corporation of Stockport, and the accounts now dealt with cover the 16 months up to the end of the financial year, including 1899. The business has been begun on very modest lines, but with every prospect of success, and with the most reasonable price of 5d. per unit for ordinary supply. The load factor will probably improve

CITY NOTES.

In answer to Mr. Crouch, the Chairman said the directors would have to trouble the shareholders for some more money than the 10s

as time goes on, but we very much question if it will be considered to have been the best policy to adopt a flat rate for charging.

GENERAL STATEMENT.

	1899.	Increase.
Total capital expenditure	£25,290	...
Number of units sold	126,177	...
Maximum load in KW.	156	...
Gross revenue	£3,938	...
Gross expenditure	£2,522	...
Gross profit	£1,416	...
Average price per unit sold	4·41d.	...

The item in the revenue statement under "Meter rentals" is unusually low. Every inducement seems to have been offered to the public to assist the new venture by commencing with low charges all round. The receipts are materially aided by the profits arising from supply of materials and work done. Thus:—

	£ s. d.
To sale and repair of arc lamps and incandescents	1,577 14 10
By repairs, maintenance, and renewals of meters, switches, fuses, together with cost of materials and lamps sold	1,301 8 1
Profit earned	£276 6 9

In the analysis these items are included as they appear in the accounts, and it will be noted that the revenue from this source equals 3d. per unit, while the expenditure amounts to 2·51d., leaving nearly a ½d. per unit difference.

REVENUE STATEMENT.

	189 . Gross.	Per unit.	1899. Gross.	Per unit.	Increase.
Sale of energy	...	...	£2,321	4·41d.	...
Meter rents, &c.	...	...	4	·01d.	...
Sale and repairs of arc lamps and incandescents	...	...	1,578	3·00d.	...
Sundry fees, interest, &c. ..	...	...	35	·07d.	...
Gross revenue ...	...	...	£3,938	7·49d.	...

For an output of just over one-eighth of a million units the costs are satisfactory, especially coal and wages, which usually suffer in a small station. Repairs, as has already been noted, includes the cost of materials sold. Therefore it is impossible to institute comparisons with other works in their first year, even if such a course were considered advisable. Eliminating the 2·51d. under repairs, the works costs appear as 1·79d. and the total cost as 2·28d. In other words, the larger half of the total cost as given is attributable to the manufacturing and fittings department, and the favourable character of the analysis can be appreciated.

COST OF PRODUCTION.

	189—. Gross.	Per unit.	1899. Gross.	Per unit.	Increase.
Coal	...	...	£267	·51d.	...
Oil, waste, water and engine room stores	...	...	177	·34d.	...
Salaries and wages incurred in generation and distribution and attending public lamps	...	...	497	·94d.	...
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and cost of materials and lamps sold	...	...	1,321	2·51d.	...
Works cost ...	...	...	£2,262	4·30d.	...
Rent, rates and taxes ..	...	...	94	·18d.	...
Management expenses, salaries of managing engineer, secretary, clerks, &c.	...	...	91	·17d.	...
General establishment charges, stationery and printing, law charges and insurance	...	...	59	·11d.	...
Other expenses	...	...	16	·03d.	...
Total costs ...	...	...	£2,522	4·79d.	...

The financial charges amount to £1,079, leaving, out of the gross profit of £1,416, £337 as net profit. This surplus is utilised to create a reserve fund by a contribution of £218, the balance of £119 being carried forward.

PROFIT STATEMENT.

	189 .	1899.
Interest on loans	...	£810
Sinking fund for repayments	...	269
Net profit carried to reserve fund	...	218
" " " forward	...	119
Gross profit	...	£1,416

Burnley Corporation Electricity Accounts.

THE accounts of the electric lighting undertaking of the Corporation of Burnley are satisfactory from the technical point of view, but do not appear quite so favourable from the financial. The business is a comparatively small one, the output being a little over a third of a million units and the capital between £51,000 and £52,000, but the extensions during last year account for one-fifth of this expenditure, while the output increased by over 25 per cent., and the load by considerably over 30 per cent. It is a rather peculiar state of affairs to find the load rising more rapidly than the output; this indicates that the adoption of the Brighton principle in its completeness would be probably advantageous to the undertaking, which at present charges a flat rate as an alternative to a scale similar to that in vogue also at Manchester. Thus, although demand indicators are used, they are not employed in the most successful way.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£40,620	£51,250	£10,630
Number of units sold	271,650	346,200	74,550
Number of lamps connected ...	19,079	21,195	2,146
Maximum load in KW.	280	387	107
Gross revenue	£4,958	£5,906	£948
Gross expenditure...	£2,351	£2,990	£639
Gross profit	£2,607	£2,916	£309
Average price per unit sold ...	3·87d.	3·64d.	—·23d.

The revenue from all sources has been augmented by about £950, while the receipts per unit have fallen by nearly 0·3d. On sale of energy alone the fall is nearly ¼d. In the statement the "sales and work done" are included, an item showing an increase of some £60. Meter rents remain practically unaffected. The average price per unit is now very reasonable, being under 3¾d.

REVENUE STATEMENT.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase
Sale of energy, &c.	£4,384	3·87d.	£5,251	3·64d.	—·23d.
Meter rents, &c...	124	·11d.	146	·10d.	—·01d.
Supply of lamps, and work done, &c.	450	·40d.	509	·35d.	—·05d.
Sundry fees	...	...	...	...	...
Gross revenue ...	£4,958	4·38d.	£5,906	4·09d.	—0·29d.

Burnley has a low coal and fuel bill, this item being only ·35d. per unit, and the rise from ·3d. to this figure is exactly balanced by the fall in "rent, rates, &c." The most marked change is in "repairs," which were £214 in 1898 and £814 in 1899, the increase being 0·37d. per unit. Thus "works costs" have increased by ·41d. Reductions in the other items have, however, practically swallowed up the increases, leaving total cost almost unaffected, under the circumstances a reasonably satisfactory result.

COST OF PRODUCTION.

	1898. Gross.	Per unit.	1899. Gross.	Per unit.	Increase.
Coal	£340	·30d.	£510	·35d.	+·05d.
Oil, waste, water and engine room stores.	129	·11d.	145	·10d.	—·01d.
Salaries and wages incurred in generation and in distribution.	458	·41d.	587	·41d.	·00d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	214	·19d.	814	·56d.	+·37d.
Works costs ...	£1,141	1·01d.	£2,056	1·42d.	+·41d.
Rent, rates and taxes ..	353	·31d.	377	·26d.	—·05d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	347	·31d.	415	·29d.	—·02d.
Establishment charges, stationery and printing, law charges and insurance	132	·12d.	40	·03d.	—·09d.
Other expenses	378	·33d.	102	·07d.	—·26d.
Total costs ...	£2,351	2·08d.	£2,990	2·07d.	—·01d.

In 1898 the financial charges absorbed £1,369 out of a gross profit of £2,607, leaving £1,238 as surplus. Out of the increase in gross revenue in 1899, amounting to £948, two-thirds, or £639, were taken up in providing for the additional expenditure, leaving an increase in the gross profit of £309. The increase in financial charges was, however, no less than £767, the result being a diminished surplus, which appears in last year's accounts as £780.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans	£766	£1,137
Sinking fund for repayments	603	999
Net profit carried to reserve fund	1,238	780
Gross profit	£2,607	£2,916

Stock Exchange Notices.—Applications have been

CITY NOTES.

Prospectus.

On Tuesday next week the list of applications opens for 4 per cent. first mortgage debentures and 5 per cent. cumulative preference shares in the General Electric Company (1900), Limited. The company has been formed for the purpose of acquiring the General Electric Company, Limited, which we are sure at this time of day needs no introduction to our readers, seeing that the business was started so long ago as 1880, although it was not registered as a limited liability company until nine years later. Since then business has expanded enormously, requiring very large manufactories and establishments at Manchester and Birmingham. This continued expansion has necessitated still further additional accommodation for the manufacture of dynamos, motors, electroliers, and other electrical appliances, and 42 acres of land have been acquired at Witton, near Birmingham, for this purpose. The new buildings and plant will cost at least £60,000. The reasons for the present reconstruction of the company are to enable the company to raise the additional capital rendered necessary by this extension of operations, and to provide the additional working capital which it requires. The management will not undergo any change whatever.

As to the capital, the nominal share capital is £800,000 in 40,000 5 per cent. cumulative preference (£10) shares, and 40,000 ordinary (£10) shares, with power to raise £200,000 4 per cent. first mortgage debenture stock. The present issue is £200,000 debentures and £250,000 each ordinary and preference. The whole of the ordinary shares, £50,000 debentures, and £70,000 preference are taken by the vendors, also £130,000 in cash (out of which they will pay off £93,700 existing debentures). The property, &c., to be taken over by the company includes land, plant and machinery valued at £161,591; stock in trade, £184,843; investments, £24,640; book debts, cash in hand and at bankers, £212,958; goodwill and patents, £92,104. The transfer dates from March 31st last, and from the above figures there has to be deducted £176,139 for debts and liabilities on that date, and profits, for the year ended on that date, reserved to vendors. The net purchase money is £500,000. It is interesting to mention that the profits for the past three years have been £51,546, £57,034 and £76,804, an average of £61,795. This is sufficient to pay the debenture and preference interest several times over. The public will be invited to subscribe for £150,000 debentures and £180,000 preference, and the list will close on Wednesday next.

As the vendors take the most risky part of the enterprise, and as the dividends on the debenture and preference capital are well covered, we consider an investment in the two latter excellent in quality.

Type-Writing Telegraph Corporation, Limited.

The statutory meeting of this company, held at Winchester House on Thursday last week, was presided over by Sir James Ferguson, who explained the present position, and stated that 26,800 shares had been taken up and allotted, making the available working capital £15,000 clear for the development of the business. It was estimated that that would be sufficient for working capital, as the Post Office and National Telephone Company paid for the instruments which they acquired through the company, which, consequently, had not to pay for those instruments in the first place. According to the *Times* report, Sir James stated that negotiations were in progress for the sale of American, German, South African, and Scandinavian patents, the profits of which, of course, would entirely come to this company, as they had acquired the whole rights. Inquiries were being received for installations, which would be fitted as fast as the instruments could be supplied. The contracts with the General Post Office and the National Telephone Company were being completed, and would probably be sealed almost immediately. The Post Office and the National Telephone Company had for a considerable time been taking those instruments and supplying them to the subscribers to private wires. The company would simply inherit that custom. The great merit of the invention was that the instruments were available for private wires, requiring no technical experts to work them, and they were also extremely useful for large engineering and other industrial works; also for exchanges for the distribution of Parliamentary, racing, and cricket telegraphic news, which could be done far more cheaply by this method than by that now in use, no batteries or expensive installations being required. It was expected that very shortly a considerable impetus would be given to this class of business in provincial towns. The invention was also specially applicable to military telegraphy, the apparatus being very portable, and by a simple arrangement the messages sent could be kept absolutely secret, it being impossible to tap the wires, while the messages were produced, not in cipher, but in plain printing. He had been asked to join the company in the capacity of chairman as being a director of the National Telephone Company, who were one of their chief customers. In the sale of the patents, if it took place, the shareholders, of course, would have a very profitable source of income.

In answer to Mr. Crouch, the Chairman said the directors would have to trouble the shareholders for some more money than the 10s. paid up, but it was not proposed to allot any more shares at present. Of course, they would have preferred to pay the vendors' shares in ready money, but that would have involved a large subscription.

Mr. Crouch: Then there is £71,000 on which dividend will have to be paid.

Mr. Gibson asked if it was not the case that there was a rival undertaking in the field that could do the work more cheaply.

The Chairman believed the so-called rival was only being applied for short distances, whereas theirs could be applied to any distance. It was also, he was informed, more expensive than theirs to work, and it reproduced the exact handwriting of the sender, which was, perhaps, a doubtful merit.

The New St. Helens and District Tramways Company.

The first annual meeting of this company was held on 8th inst. at Liverpool.

Sir John A. Willox, M.P., presided, and in moving the adoption of the report, said that the company was formed to take over the business of a predecessor who had worked the steam tramways of St. Helens, and also to acquire from the Corporation of St. Helens the working of the new and extended system of electrical tramways which they were constructing. Some time ago the Corporation of St. Helens obtained Parliamentary powers to lay down tramways within the borough and the adjacent districts, the system to be worked by electricity. They granted a lease of the whole system to this company for 21 years. The Corporation undertook to lay down the rails and the electrical equipment, and to supply the motive power. The company provide the rolling stock and the staff for working on the lines. It was not necessary to trouble them with all the details as to rent and terms or charges to be made for electrical power. The material fact for their consideration, then, was that rent began to accrue from the date of the lease. But while the rental was thus accruing, the electric tramways were not ready for use. At the outset the company was therefore at some disadvantage financially. It had to pay rent, but was not in a position to recoup itself by the revenue arising from traffic. It was seven months after the company came into existence before their first electric section was opened, namely, that between St. Helens and Prescot. Since then other sections had been opened, and the work was being pressed forward vigorously. At the date of the report, June 30th, only about one-half of the tramway system had been completed, but since then other sections had been finished and opened, and in a comparatively short time fully 20 miles of rails would be available. The directors made no complaint against the Corporation of lack of energy in pushing forward the work. They all knew that there was a great demand for electrical appliances at present, and that contractors were unable to finish their work within the stipulated time. The delays at St. Helens might, no doubt, have arisen from unavoidable causes, and they must endure them with patience. But the result had been rather hard upon this company. They had been paying rent, providing rolling stock, and incurring all the charges of administration, and had not been able to recoup themselves by the receipts from traffic. However, that state of things was now coming to an end, and they might look with confidence to the whole system being brought into working order and producing a favourable revenue within a reasonable time. The directors ordered an ample equipment of cars and they were delivered so promptly that as each section of lines was passed by the Board of Trade the service in that section was commenced on the very next day. They had such an abundant stock of cars already on hand that they were in a position to commence the service whenever the lines were ready for use. Therefore, there would be no delay on their part either in utilising the lines or in providing for the public convenience. It was only right to give a word of praise to the Corporation for the excellence of their supply of power. It had been adequate and uninterrupted, and the efficiency of the company's service had been largely due to this fact. The public were eager to avail themselves of their rapid and cheap system of locomotion. The receipts of the various sections now in use were large and progressive, and realised the expectation of the directors. It was impossible, however, to form a sound judgment on a business that had not got into full working order. As additional lines were opened the receipts would increase, while the rental and administrative charges would remain practically the same. They might, therefore, look with confidence to the future, both as to the carrying power of the company and the profit on the business. For the reasons already explained, the finances for the period under review had been dislocated, and it had been necessary to hold some items of charge in suspense. This was a temporary measure, and would be adjusted when the company got into full work. Different sections fed each other, and every extension augmented the traffic on the system. An important factor in this respect would probably be the South Lancashire Tramway Company. Parliament had sanctioned the construction of an elaborate system of electric tramways in the populous district between Liverpool and Manchester for passenger and goods traffic. The St. Helens tramways would be an essential link in this important network of cheap locomotion, and it would be the policy of the board to encourage its development, knowing that it would be advantageous to the public and to the company. They had assumed no financial obligations in relation to the South Lancashire scheme.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to:—United River Plate Telephone Company, Limited.—Further issue of 23,361 5 per cent. cumulative preference shares of £5 each, and to allow the following to be quoted in the Official List:—National Telephone Company, Limited.—£500,000 4 per cent. debenture stock. The Committee has appointed Wednesday, October 17th, a special settling day in St. James's and Pall Mall Electric Light Company, Limited—£150,000 3½ per cent. debenture stock, and has ordered same to be quoted in the Official List. The Committee has been asked to allow to be quoted officially, Folkestone Electricity Supply Company—10,000 ordinary shares of £5 each, fully paid, Nos. 1 to 10,000. (Renewed application.)

Siam.—The *London and China Telegraph* says that an extraordinary general meeting of the Siam Electric Railway Company has been held at the offices of the Siam Electricity Company, Limited, for the purpose of formally winding the company up as required according to the Danish law, notwithstanding the fact that it had not been registered. Mr. Westenholz proposed the following resolution:—"That the Siam Electric Railway Company be dissolved, its property and rights to be disposed of as the directors deem best for the common interest." Captain de Richelieu seconded, and the resolution was carried. It is understood that the company will be taken over by the Siam Electricity Company, Limited.

Oriental Telephone and Electric Company, Limited.—The directors have declared an interim dividend of 2½ per cent. (being at the rate of 5 per cent. per annum) on the paid up capital of the company, free of income-tax, payable to those shareholders whose names are on the register at this date. The warrants will be posted on 31st inst.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. per share, free of income-tax, being at the rate of 3 per cent. per annum for the quarter ending September 30th, 1900, such dividend to be payable on and after the 26th inst.

Newcastle Electric Supply Company.—At an extraordinary general meeting of this company, held on the 4th inst., a resolution was passed to alter the article of association affecting the appointment of directors.

Dick, Kerr & Co., Limited.—A meeting of this company was held at the offices, 110, Cannon Street, E.C., on Friday last, but the proceedings were conducted in private.

Cuba Submarine Telegraph Company.—Dividend recommended on the ordinary shares for half-year ended June 30th, 5 per cent. per annum.

Submarine Cables Trust.—On and after 15th inst. coupons due on that date will be paid by Messrs. Glyn, Mills, Currie and Co.

Reuter's Telegram Company.—Interim dividend for the half-year to June 30th, 5 per cent.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending October 6th, 1900, were £407 14s. 11d.; receipts for corresponding period, 1899, £422 6s. 11d.; aggregate for half-year to date, £18,070 18s. 9d.; aggregate corresponding period of last half-year, £17,958 7s. 5d.

The Bristol Tramways and Carriage Company.—The receipts for the week ending October 6th, 1900, were £3,305 7s. 6d.; corresponding period, 1899, £2,943 10s. 3d.; increase, £361 17s. 3d.

The Central London Railway.—The receipts for the week ending October 6th, 1900, were £5,103; previous week, £5,208; decrease, £105. Total receipts to October 6th, 1900 (10 weeks), £47,510. Miles open, 6.

The City and South London Railway Company.—The receipts for the week ending October 7th, 1900, £1,616; October 8th, 1899, £1,019; increase, £597. Total receipts for half-year, 1900, to date, £21,227; corresponding period, 1899, £18,204; increase, £3,033. Miles open, 1900, 4½; 1899, 3½.

The Cork Electric Tramways and Lighting Company.—The receipts for the week ending Thursday, October 4th, 1900, were £458 1s. 11d.; corresponding week last year, £390 18s. 2d.; increase, £67 3s. 9d. Total to October 4th, 1900, £16,625 4s. 6d.; corresponding period last year, £15,240 2s. 1d.; increase, £1,385 2s. 5d.

The Dover Corporation Tramways.—The receipts for the week ending October 6th, 1900, were £224 9s. 8d.; October 6th, 1899, £202 7s. 7d.; increase, £22 2s. 1d. Total receipts to date, 1900, £8,458 1s. 10½d.; corresponding period, 1899, £8,075 1s. 7d.; increase, £383 0s. 3½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,977; 1899, 4,728. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, October 5th, 1900, were as follows:—D. U. T. Co., horse cars, £27 2s. 2d.; ditto, electric cars, £3,628 18s. 1d.; D. S. D. Co., electric cars, £86 9s. 11d.; total, £4,487 10s. 2d; corresponding week last year—D. U. T. Co., horse cars, £1,109 1s. 6d.; ditto, electric cars, £1,8·5 1s. 6d.; D. S. D. Co., electric cars, £720 6s. 6d.; total, £3,714 9s. 6d.; increase, £773 0s. 8d.; aggregate to date, £69,621 8s. 0d.; aggregate to date last year, £62,878 6s. 11d.; increase to date, £7,243 1s. 1d. The mileage worked is 44 miles electrically, 1 mile by horses, as against 24 miles electrically, 20 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending October 7th, 1900, were £1,593; corresponding week last year, £1,462; increase, £130. Total traffics from July 1st, 1900, £24,573; ditto corresponding period, 1899, £23,079; increase, £1,198. Miles open, 6·57 chains.

STOCKS AND SHARES.

Wednesday Evening.

While it looked at the beginning of the week as though the markets of the Stock Exchange were about to make a sharp upward move, the feeling of hopefulness thereby engendered was doomed to rapid disappointment. A sharp fall in the New York exchange on London caused a break in the price of Consols, which reacted unfavourably on all the investment departments. Fears of dearer money were again to the front in the twinkling of a thought, and pessimism ran rife through the Stock Exchange. As a consequence, the majority of changes which we record are in a downward direction, but they are comparatively insignificant. Taken all together the decline is only ½ per cent. more than the two points rise secured by Waterloo and City Railway Ordinary stock.

Electric railways are bulking so largely in the public eye that the market in what shares now exist is receiving some amount of general attention. The advance in Waterloo and City stock has taken the price up to 95½, at which it hardly looks cheap. Central Londons are also better, the Undivided having put on 5s. There is some inquiry for the Deferred half shares, and (although the movement is not shown in the official quotation) they are ⅛ better than the Preferred half-shares, the exact prices being 5¼ and 5⅛ respectively. The 4 per cent. dividend prophecy is still in favour with the market, while an electrical engineer closely connected with the line declared to us the other day that the company cannot pay more than 3 per cent. It must be another three months before the accuracy of either forecast can be proved, and many things may happen in the interim.

"Tube" talk is very much in evidence nowadays in the Stock Exchange, and the latest idea is that the Metropolitan District Company will construct an electric line exactly underneath their present tunnel. We should rather like to know where the money is coming from. Then there is the London, Brighton & South Coast Railway flirting with the question of a "tube" to relieve the congestion of its traffic at London Bridge Station. The Great Eastern directors are already moving, and it would appear that the American syndicate which has the Charing Cross to Hampstead Railway in hand is on the point of beginning operations, the necessary 12½ million dollars having been subscribed. What with these proposals, together with the City & South London extensions, the Baker Street & Waterloo, and the Great Northern & City, now in course of construction, the electric railway market may in time grow into a powerful and active department.

Nothwithstanding the strength of the railway market, British Electric Traction shares are flat. We have already referred to the circular lately issued by the board urging shareholders to take up their proportion of new shares if they had not already done so. In spite of this, there were still a good many proprietors who did not avail themselves of the opportunity presented to them to get cheap stock, and we understand that the people to whom these surplus shares were finally offered took them eagerly, although, in order to pay for them they had to sell some of their old shares. Hence this fall in the latter.

Electricity Supply descriptions are, in market parlance, "as hard as nails." Metropolitans are, perhaps, the most in demand, but there is healthy investment going on all down the list as the public realise how excellent is the security afforded by the best class of these shares. Bournemouth and Poole Ordinary have again advanced ½ to 13, upon the rumours as to the acquisition of the undertaking by the local authority, to which we referred last week.

In the telegraph division, Anglo-American stocks are still further depressed this week. The market explanation of the drop is nothing more novel than that the securities have been pressed for sale and that no buyers have come along to support quotations. The Eastern Companies' stocks exhibit no nominal variation, although the prices are actually a shade harder. Wireless Telegraphy shares are now standing at £3 to £4.

So long on the down grade, the price of National Telephone shares at last shows an improving tendency. Considering the high rate of interest which they pay, the Ordinary look a fair speculative risk. While they have risen 2s. 6d., the Third Preferences are down 5s., the shares thus maintaining their reputation for moving in contrary directions. The latest Debentures—soon to be granted an official quotation—are 103 to 105.

Beyond a slight fall in India-Rubber shares, the miscellaneous department presents no features. The Welsbach Company wants another quarter of a million sterling in order to develop its electric mantle and general trade.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation October 3rd.	Closing Quotation October 10th.	Business done during week ended October 10th, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	59 — 62	58 — 61	59	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	109½—110½	109 110	110¼	109½
3,062,240	Do. do. Deferred	Stock	...	18s. %	£1 7s.	11 — 11½	10⅞— 11¼	11 1/16	10⅞
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	165 —175 xd	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	100 —102 xd	100 —102	102	101⅜
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5 xd	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10 xd	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 —104 %	...	...
60,710£	Direct United States Cable	20	3¼%	3¼%	3 %	10⅜— 11¼	10⅜— 11¼	11	10½
111,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	149 —154	149 —154	150¾	149½
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	99 —102	99 —102	101	99½
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	114 —119	114 —119	114	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	15 — 15½	15 — 15¼	15⅜	15⅛
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	... — ...	... — ...	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	... — ...	... — ...	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	113 —118	113 —118	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	100	99½
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5½%	10⅜— 11¼	10⅜—11¼	11⅛	11 1/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½	15⅜	15
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	31 — 33	31 — 33	...	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —101	98 —101	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	49 — 53	49 — 53	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ⅛	¼— ⅛	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅜— 4⅝	4½— 4¾	4 1/16	4½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	13⅞	13½
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5⅛— 5⅜	5 — 5¼	5⅛	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	97 —100	97 —100	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— 1⅛	⅝— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	126 —131	126 —131	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4¾— 5¼	4¾— 5¼	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs....	100	...	...	...	98 —101	98 —101	101	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Brzn. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	... — ...	... — ...	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14¾— 15¼	14¾—15¼	15	14⅞
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph	10	⅛%	2 %	⅛%	¾— 1	¾— 1	1 1/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	6½— 7½	6½— 7½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	6 — 7	6 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	105 —108	105 —108	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref....	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9 — 10	9 — 10	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6½— 7½	6½— 7½	...	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	4½%	...	...	110 —113	110 —113	111½	110
60,000	City of London Electric Lighting, Ord. 40,001—100,000...	10	10 %	6 %	4 %	8½— 9½	8½— 9½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12½—13½	12½— 13½	13½	13⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11 — 12	11 — 12	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	107 —110	107 —110	...	...
26,100	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	100 —103	100 —103	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1⅞— 2¼	1⅞— 2¼	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4½— 5½	4½— 5½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	13 — 14	13 — 14	13⅜	13⅜
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	111 —114	111 —114	...	...
220,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	97 — 100	98½	98
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	15 — 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	15⅜	15⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	3 — 4	3 — 4	3½	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	12 %	13 %	12 — 13	12 — 13	12⅜	12½

* Subject to Founders Shares.
‡ Unless otherwise stated all shares are fully paid.
—Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Oct. 3rd.	Closing Quotation Oct. 10th.	Business done week ended Oct. 10th, 1900. Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	9 — 10	9 — 10	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	93 — 97	93 — 97	...	...
30,000	British Electric Traction	10	...	6 %	...	14 — 15	13½ — 14½	14½	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12⅝	12⅝
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123xd	120 —123	121¼	121
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	⅜ — ½	⅜ — ½	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	⅜ — ½	⅜ — ½	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000 ...	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,000 ...	5	...	...	...	5⅝ — 6¼	5⅝ — 6¼	...	...
105,731	Brush Elecl. Enging., Ord., 1 to 90,000	2	3 %	5 %	6 %	1¾ — 2	1¾ — 2	1 1/16	...
105,731	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	6 %	2⅛ — 2⅜	2⅛ — 2⅜	2 1/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	106 —111	...	...
125,000	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	102 —104	102 —104	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½ %	15 %	15 %	12½ — 13½	12½ — 13½	13 5/16	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5 — 5½	5 — 5½	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	110 —114	110 —114	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10¼ — 10⅝	10½	10⅜
61,033	Do. do. Pref. half-shares	5	...	...	...	5 — 5½	5 — 5½	5⅝	...
71,447	Do. do. Def. do.	5	...	...	...	5 — 5½	5 — 5½	5⅝	5½
855,000	City and South London Railway	Stock	1⅞ %	2⅛ %	1⅞ %	58 — 61	58 — 61	61	58½
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000 ...	10	...	...	...	5 — 6	5 — 6	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	7½ %	3⅜ — 4¼	3⅜ — 4¼	3 1/16	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1⅜ — 2¼	1⅜ — 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3½ — 4⅛	3½ — 4⅛	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	90 — 92	90 — 92	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	7 %	...	2⅜ — 3¼	2⅜ — 3¼	...	...
140,300	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	12½ — 13⅝	12½ — 13⅝	13¼	12⅝
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5 — 5⅛	5 — 5⅛	5⅛	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½ — 21½	20 — 21	20½	20 7/16
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	99 —102 xd	99 —102	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼ %	3¼ %	3¾ %	8⅝ — 8⅞	8⅝ — 9	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5	12⅝ — 13¼	12⅝ — 13¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 38	34 — 38	35	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	... %	101 — 104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10½ — 11⅜	10½ — 11⅜	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5 — 5⅛xd	5 — 5⅛	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	92 — 95	94 — 97	96	93½

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 103—106.
National Electric Free Wiring, 12/6 paid, ⅜—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16½—17½.
Do. do. Pref. (£10 pd.), 10—10½.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 % £5 (fully paid), 6¾—7½. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17½.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, October 10th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	29/-	29/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10s.	£33	10s. inc.
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10s.	£17	10s. inc.
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160°C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3¼d.	3¼d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	62/-	66/-	4s. dec.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£294	£294	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £150	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¾d.	8¾d.	..
c ,, Wire, basis	per lb.	8¾d.	8¾d.	..
c Copper Tubes (brazed)	per lb.	11½d.	11½d.	..
c ,, ,, (solid drawn) ..	per lb.	11d.	11d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
e ,, (Electrolytic) Bars ..	per ton	£83 10	£83 10	..
e ,, ,, Sheets ..	per ton	£92	£92	..
e ,, ,, Rod ..	per ton	£85 10	£85 10	..
e ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/6	8/6	..
h India-rubber, Para fine	per lb.	4/3 to 4/4	4/3	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	68/6	67/-	1s. 6d. inc.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£12 5	£12 5	..
g Lead, English Ingot	per ton	£18 5 to £18 7 6	£18 5 to £18 7 6	..
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	9d. to 9d.	9d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 13 6	£3 13 6	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£53	£53	..
g Tin, block	per ton	£137 to £138	£139 to £140	dec.
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals —				
"White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 2 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne bnd.)	per ton	£24 5 nett	£24 5 nett.	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yee & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRADFORD 1900.

SMALL SCREW GAUGE.

Report of the Committee, consisting of Sir W. H. Preece (chairman), Lord Kelvin, Sir F. J. Bramwell, Sir H. Trueman Wood, Major-Gen. Webber, Col. Watkin, Messrs. R. E. Crompton, A. Stroh, A. Le Neve Foster, C. J. Hewitt, G. K. B. Elphinstone, E. Rigg, C. V. Boys, J. Marshall Gorham, and W. A. Price (secretary), appointed for the purpose of considering whether the British Association form of thread for small screws should be modified, and if so, in what direction. Drawn up by the secretary.

(*Section G, September 11th.*)

(*Continued from page* 563.)

In constructing plug gauges for testing nuts the straight sides of the thread can be corrected after hardening by grinding with a lap, and this process corrects at once the irregularities of pitch and angle, and is continued till the effective diameter is reduced to the desired value. The top of the thread, being cylindrical, presents no difficulty. The form of the bottom of the thread is immaterial, since the clear hole in the nut is most conveniently tested with a cylinder plug gauge. In the specimens submitted to us last year by the Pratt & Whitney Company this cylinder was constructed in one piece with the screwed plug.

In ring or nut gauges for testing screws a slit is cut through the tapped hole, and closed with a screw. The hole can be polished by a corresponding screwed piece, but could only be corrected by grinding, by the use of very refined appliances. After polishing, the slit is closed to fit a prepared screwed plug, and the clear hole brought to its correct value with a lap. The process is not so satisfactory as with a plug gauge, but the pieces which the ring is designed to test can be satisfactorily measured in other ways, so that the gauge is of less importance.

The effective diameter of a screw is readily measured in a micrometer gauge between a conical point and a V notch, both having an angle of 47½°. An instrument of this kind constructed for 60° is figured in tool makers' catalogues.

Ordinary taps for nuts or for the working holes in larger pieces will be different in form from the screws, and different from the taps employed to make dies or screw plates. The ordinary dies or plates in a workshop used for making screws will not be suitable for making taps. In small workshops this may sometimes cause mistakes, but in shops having a separate tool room this extra specialisation should present no difficulty.

Objections have been raised to the above proposal on three grounds.

It has been represented to us that in finely-fitted work the screws should fit their holes perfectly and all over, and that the existence of a clearance gap all round the edge of the thread is inconsistent with a high standard of workmanship. This objection is evidently to some extent a matter of opinion, and it is always possible to use taps of the same form as the screws, so that the screws will fit the taps all over as in a non-clearance system.

It has been objected that the introduction of the proposed system will seriously interfere with existing stocks of screws and the repairs of existing instruments. In fig. 2 it is shown that the new thread differs from the old one by the addition of the small corners, g B h, h B k, to the screw, and d A′ e, e A′ f, to the nut. In making screws and nuts with dies and taps, these corners will always be rounded off to some extent, though the re-entrant angles at A B′ will be as sharp as the tool which makes them. In some screws and nuts prepared experimentally to test this point, the outer edges of the thread were fairly rounded, and they were perfectly interchangeable with the B.A. screws of an existing manufacturer's stock. The Committee believe that screws made to the proposed new thread will, owing to the inevitable rounding, be interchangeable with existing stocks in a great majority of cases, and that only in cases where great care has been taken to work closely to the old standard will any difference be noticed.

It has been objected that the proposed thread is unsuitable for bicycles and small arms, which are subject to violent concussion and vibration, whereby the screws are liable to be shaken loose and to drop out; and the case of alternating current arc lamps has been mentioned to the Committee as one in which the same thing is liable to occur. Mr. O. P. Clements, of the Birmingham Small Arms Company, contributes a paper to the *Transactions* of the section on the practice of his firm in the manufacture of screws for bicycle parts, for which he has found it necessary to use rounded threads fitting very closely all over. It is clear that no one form of thread can be suitable for all purposes, and we have direct evidence that the form of thread we propose does not fail in instrument work in the way Mr. Clements anticipates that it would do in bicycle work.

We beg to report that the system of screw threads recommended by the British Association for the use of instrument makers, and known as the British Association screw threads, should be modified in the following way for all screws from No. 0 to No. 11, inclusive.

For Screws.—That the designating numbers, pitches, outside diameters, and the common angle of 47½° remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch, the diameter of the solid core being, in consequence, diminished by one-fifth of the pitch.

For Nuts.—That the designating numbers, the pitches, the diameters of the clear holes, and the common angle of 47½° remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch.

The appended table gives the pitches and diameters of the different threads modified in accordance with this recommendation.

Table of the Pitches and Diameters of the British Association Thread under the Rule proposed above.

No.	Pitch.		Screw.				Nut.			
	—		Outside diameter.		Inside diameter.		Outside diameter.		Inside diameter.	
	Millimetres.	Mils.	Millimetres.	Mils.	Millimetres.	Mils.	Millimetres.	Mils.	Millimetres.	Mils.
0	1·0	39·4	6·0	236·2	4·6	181·1	6·2	244·1	4·8	189·0
1	·9	35·4	5·3	208·7	4·04	159·1	5·48	215·8	4·22	166·2
2	·81	31·9	4·7	185·0	3·566	140·4	4·862	191·4	3·728	146·8
3	·73	28·7	4·1	161·4	3·078	121·2	4·246	167·2	3·224	126·9
4	·66	26·0	3·6	141·7	2·676	105·4	3·732	146·9	2·808	110·6
5	·59	23·2	3·2	126·0	2·374	93·5	3·318	130·6	2·492	98·1
6	·53	20·9	2·8	110·2	2·058	81·0	2·906	114·4	2·164	85·2
7	·48	18·9	2·5	98·4	1·828	72·0	2·596	102·2	1·924	75·7
8	·43	16·9	2·2	86·6	1·598	62·9	2·286	90·0	1·684	66·3
9	·39	15·4	1·9	74·8	1·354	53·3	1·978	77·9	1·432	56·4
10	·35	13·8	1·7	66·9	1·210	47·6	1·77	69·7	1·280	50·4
11	·31	12·2	1·5	59·1	1·066	42·0	1·562	61·5	1·128	44·4

In order to give practical effect to our recommendations, we desire to obtain a set of the proposed screws, with tools and gauges, for comparison with the present ones. We shall thus be able to exhibit in a concrete form the character of the thread, and also to show how far screws made with the new tools are interchangeable with the existing stocks. We recommend that the Committee shall be re-appointed for this purpose with a grant of £45.

APPENDIX.

Report of Experiments on Screw-Threads made by J. Marshall Gorham and W. A. Price.

The object of these experiments was to determine the relative advantages of different angles for the threads of small screws, and two questions were proposed for trial:—

1. Which angle gives the greatest frictional torque to resist unscrewing?

2. Which angle gives the greatest resistance to the tearing of a steel screw out of a brass plate or nut?

To answer these questions, six pieces, of the form of fig. 3, were

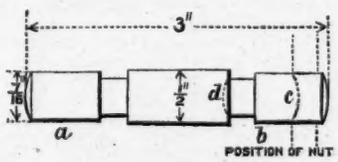


Fig. 3.

made of steel. On one end, a, of each a thread was cut which was the same in every case, and was used only for the purpose of connecting the pieces in the testing machine. The threads to be compared were cut on the ends, b. Three kinds of thread were tried, two pieces being made of each kind of thread.

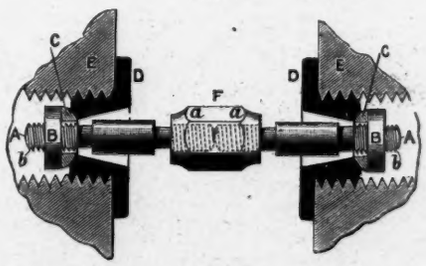


Fig. 4.

The mode of trial is shown in fig. 4. A pair of these steel pieces, A A, having threads of the same kind at the ends, b b, were tightly screwed by the ends, a a, into a sleeve, F, so that they could not be unscrewed by the forces employed in the test. On the ends, b b, were placed brass nuts, B B, supported on steel collars, C C, which

rested in spherical seats in the brass pieces, D D. These last pieces, D D, were screwed into E E, the cast-iron terminal blocks of the testing machine.

Two experiments were made in each case.

1. With a steady pull on the specimens, the torque required to turn both screws simultaneously in their nuts was measured. This was ascertained by means of a small spring balance acting by a lever on the hexagonal sleeve, F.

2. The pull of the testing machine was then steadily increased until one of the screws was pulled through the nut.

The screwed pieces, A A, were turned out of tool steel, bright drawn rods of clockmakers' silver steel, ½ inch diameter. The main object of the experiments being to find the force required to shear the thread out of the nuts, B B, by screws of given form, any deformation of the screw itself had to be avoided. The *b* ends of the steel pieces were accordingly water-hardened, and let down to a spring temper. In the course of testing, one out of each pair of steel screws broke at the point where it entered the brass nut, at a strain much below the calculated breaking strain. The form of the fracture was in every case that of the dotted line, *c*, shown in fig. 3. Prof. Unwin, to whom this point was submitted, supposes that this had no bearing on the strength or weakness of the particular forms of thread used, but was due to internal strains in the steel produced by the water-hardening, and to a slight bending force acting with maximum effect at the point where the screw enters the nut. The spherical seats of the collars, C C, will not, he points out, wholly prevent the occurrence of this force. He suggests that had the screws been hardened in oil, this probably would not have happened. The sectional area of the cores of the screws was ·095 square inch, and the breaking strain was expected to be about 13,500 lbs. Those that broke where they entered the nut broke at 5,600 lbs. (60° screw), 5,860 lbs. (50° screw), and 5,330 lbs. (40° screw) respectively. In a subsequent test one of them broke along the line, *d* (fig. 3), at 10,280 lbs. Fortunately, in every case, a sufficient length of the screw was left after the accident to put on another nut, and in each case a satisfactory result was obtained in a subsequent trial, the screws being drawn through the nuts without being themselves broken.

(*To be continued.*)

THE OPERATION OF A COMBINED LIGHTING AND POWER PLANT.*

By J. H. PERKINS.

In the early days the attention of managers was soon called to the fact that the supplying of a comparatively large amount of current for so short a time, as is the case in an ordinary commercial-lighting plant, was an expensive and rather unsatisfactory operation, necessitating either high rates and a limited use of the service, or the unprofitable running of the plant.

Following up this idea came the introduction of motor and street-railway service, which materially helped matters by giving some day load. But still, in most of the plants, this power service was rendered from as many different kinds of machines, they very often being driven by separate engines. The result was that we find to-day, many plants composed of several classes of machines, each rendering its separate service, with no possibility of helping out one another in time of trouble, or of being combined as needed for the variation of load during the day. Each machine must do its service, whether there is light load or full load. This was and is an inefficient, unreliable and unsatisfactory way to run a plant of variable load and service. The best dividend-earning plant is one which, first, has the long-hour service, and, second, the one which is operated with economy and reliability. The first means the furnishing of as many kinds of service as possible to get the load distributed throughout the 24 hours; the second means the concentration of all classes of service in the same type of machines of various sizes to be combined as the load requires, and to be interchangeable for reliability of service.

This brings us to the advent of multiphase alternating current apparatus, which has made these refinements possible, and some plants of this type have already been installed. The plant which I represent at Youngstown has been through exactly this cycle of changes, and it is from the experience with its operation that I give this paper.

We have attempted a difficult problem, that of giving satisfactory lighting, motor, and street railway service from the same system, all machines running in parallel and interchangeable. It is true that the correct plan for one plant may not be correct for another, and each plant must work out its own individual system, but by adhering to general outlines we may gain ideas which will apply to all.

At Youngstown we are furnishing almost all classes of service from exactly the same machines and engines, and, at times from the same bus bars. The service includes incandescent lights, arc lights, fans, single and two-phase motors, and a street railway. The system in general is two-phase, 60 cycles, 2,000 volts, the lines being at a pressure of 2,000 volts direct from the bus bars, without station transformers. We still have many small machines of different classes scattered about the station. Some of these are run by two-phase motors, but there is no class of service which we do not furnish, in part, from the alternating current system, and eventually all of the small machines will be discarded, and the service transferred. At the time of the installation of the multiphase apparatus the plant had very little power work to turn over to this service, and only a few arc lights, which had been installed on 16,000 alternations.

The incandescent lighting was planned for supply from a number of single-phase circuits, each circuit controlled by a double-throw switch to throw the circuit to either phase in case of unbalance. The switchboard panel contains the ammeters, switches, and fuse blocks. No provision was made for regulation, all circuits coming direct from the bus bars and at the same voltage. At this time the primary voltage was changed from 1,000 to 2,000, and secondary from 50 to 100. It was only by reason of this better efficiency in the lines and of close regulating transformers that good regulation was possible. At present we do not get very good results, but I believe that in time we shall have to put a regulator on each circuit with a voltmeter, regulating each circuit according to its needs, and I think a well-designed plant should have this latter arrangement.

Arc Lighting.

The old series open-arc commercial arc lighting is gradually being transferred to constant potential alternating current lamps run from the same system of wiring and transformers as the incandescents. We believe that this has done a great deal to make us more money:—First, the station apparatus is more simple, more efficient, and more reliable than the old series apparatus; in fact, it brings the service to a common basis with incandescents. Second, on a meter system you get your pay for service rendered, and customers do not use the light except when needed. Third, if one consumer happens to have a dark store you do not have to turn on the whole system in order to supply this one. He can have the light when he wants it, but he pays for what he uses. In this system you are master of your business, and I think you will agree with me when I say that with the series arc system for commercial service on contract rates, you are not a master of your business to its fullest extent. We need no extra man for people on this new system, and the consumers are satisfied that the light is more steady, better appearing, cleaner, and more reliable than the old system. Some question the volume of light, but we have never had a consumer change back from the alternating current enclosed to the direct current series open when once the former had been installed, except where the consumer was not willing to go on the meter system.

The question may be asked, "Do you find the operation of alternating current enclosed lamps successful?" In answer, I will state that at the start we did have trouble, but we have finally come to the point where we have little or none, in fact, as little as with the old series direct current lamps. By the introduction of these new arcs we have acquired considerable business around mills and factories running on night turn, which we have been unable to take with the other system.

Motor Service.

Our consumers own their motors, and can, of course, get very little for a second-hand direct current machine; therefore the transfer to alternating current is slow. When possible, all new work has been put in on the alternating system, and the old direct current machines are gradually coming out.

The first motors were installed by combining two single-phase lighting circuits on opposite phases for two-phase motors, or on any of the single-phase circuits for single-phase motors. With the increase of motors the tax on the lighting feeders was too great, and it was sometimes inconvenient to keep these two circuits on opposite phases. We therefore made up a separate two-phase power circuit coming from the same bus bars, retaining, however, the single-phase motors on the lighting circuits.

The two-phase motor circuit is arranged with a double-throw switch to operate from either the lighting or power bus bars. The power bus bars are referred to later on. By this arrangement it is possible to separate the motors from the lighting altogether.

The question most discussed in this connection is, "What will be the effect on the lighting?" This is hard to answer on paper, and the best answer is an inspection of the service in operation.

The large inductive current on the starting of an alternating current motor is inherent, and the designers say we must always have at least some. The effect of this inductive current on the transformers and generators is the cause of poor regulation. The question is, how much will it affect the lights? There is considerable difference in transformers on inductive drop. A certain transformer may have very good regulation on non-inductive or lamp load, but on a motor load it may be very poor. The choosing of transformers for this work must be done carefully. However, if the motors and lamps are not fed from the same transformers, this will not apply, and it is more apt to be the case, for with motors of large size there will probably be a separate service.

I would call attention more forcibly, however, to the effect on the generator from the starting of alternating current motors. Central station men make a great mistake in expecting good regulation in the operation of motors on small generators. The regulation of alternating current generators on inductive load is inherently poor. To be sure, there is a difference in generators, but any of them are poor enough. The capacity of the generator must be relatively very large to that of a motor, that the starting may not show on the lights.

As to the results in Youngstown:—Our smallest generator has a capacity of 75 KW., and it generally carries the day lighting and

* Read before the Ohio Electric Light Association, at Toledo, O., August 15th, 1900. Mr. Perkins is assistant manager of the Youngstown Gas and Electric Company at Youngstown, O.

motor load. At noontime one can tell when the separate motors go on, by momentary drops in the voltage of from 1 to 5 per cent., according to the motors, which average from ½ to 10 H.P. But you must remember that this is only during the day at a time when this is not objectionable, and there would be no appreciable effect with the larger generator during the evening; and I think that I can safely say that we, at no time, have any effect on the lights from motors which any consumer or station manager could complain about; at least, we have no trouble from this source. There might be trouble with some of the smaller stations in trying to run motors on small generators at all times of the day, and I would recommend careful consideration against small, poor regulating generators on inductive loads for this service.

As to the difference in the effect of single and multiphase motors on the lights, we find none, and it becomes a question of ease and expense of installation between the two.

As yet we have no series street arc lighting on the alternating current system, having gone no further than a few experiments, but in discussing this point of inductive drop in generators it may be well to add that the regulating apparatus of the arc system will have more or less the same effect as the starting of motors, and with some form of apparatus now being advocated, there must surely be an effect on incandescent lighting.

(To be concluded.)

FLY-WHEEL CALCULATIONS.

A few figures and examples of the data and results of fly-wheel calculations supplied to *Cassier's Magazine* by Mr. A. W. Wansbrough, may be useful. The total stored energy in a fly-wheel is given by the customary formula $\frac{W v^2}{2g}$, where W is in pounds and v is the velocity of rim in feet per second. The boss and arms may be neglected, as this neglect simply improves the results obtained. Thus a 2,000-lbs. rim at 80½ feet per second will have a stored energy of 201,250 foot-pounds. The regularity of turning velocity under the variable effort applied to the crank pin depends obviously upon the ratio of such effort to the total rim energy. There are several duties that must be performed by a fly-wheel. Its first duty is to spread the inequality of engine effort over a whole cycle so evenly that the variation of speed during any part of a cycle shall not exceed a given amount. The second duty is to perform the same function for any variation of load such that the speed may be kept within certain limits defined by the governor and fly-wheel acting together. The governor controls the number of revolutions per minute within a certain percentage, and it is obvious that if a governor is sensitive to within 2 per cent. and the fly-wheel is only sensitive to something over 2 per cent. there will be a rise and fall of the governor twice in each complete revolution of an ordinary engine—*i.e.*, a rise and fall each cycle of events. The variation of turning effort in all engines depends upon many factors. The chief is the fluctuation K or Δ E of energy at the crank pin, and for reciprocating engines is usually awarded the following values:—

Early cut-off double-cylinder engines ...	K = ·037
Cross-compound receiver engines	K = ·04
Single-cylinder non-expansive	K = ·21
Tandem. Full admission to half stroke ...	K = ·125 to ·2
Single-cylinder condensing...	K = ·143
Single-cylinder, cut-off at half stroke ...	K = ·15
High speed, shaft governor	K = ·36
Single-acting hydraulic	K = ·5
Gas engines, Otto cycles	K = 1·5

To make this clear the worst case of the gas engine is cited where K = 1·5. Suppose the engine runs at N revs. per minute and indicates 1 H.P. Then the foot-pounds of work per revolution are $\frac{33{,}000}{N}$ and in the one explosive stroke there must be supplied not only the energy for that half stroke, but for three other non-explosive strokes or 1·5 revolutions, or $1{\cdot}5 \times \frac{33{,}000}{N}$ foot-pounds. All this time the speed must not vary more than, say, 1 per cent. above or below normal, or 2 per cent. in all. K being 1·5 or $\frac{3}{2}$, we have

$$\cdot 04 \times \frac{W v^2}{2g} = \frac{3}{2} \times \frac{33{,}000}{N},$$

that is, 2 per cent. of the fly-wheel energy must not be less than 1½ times the work of one revolution. Reducing v^2 into terms of diameter and rotative speed, and reducing to tons, we have

$$v^2 = \frac{\pi^2 \times D^2 \times N^2}{60^2}, \text{ and } W \text{ in tons} = \frac{K}{\cdot 04} \times \frac{344{,}000}{D^2 N^2},$$

a formula that is easily specialised for any case by putting in the value of K for the particular case, and in place of the divisor ·04, or 2 per cent., substituting any other figure according to the percentage of variation to be allowed.

Thus an engine of 100 H.P. has K = ·228, D = 10·52 feet, N = 90, and is permitted to vary 1 per cent. from the normal, or 2 per cent. overall.

$$\text{Then } W = \frac{\cdot 228}{\cdot 04} \times \frac{344{,}000}{110{\cdot}67 \times 729{,}000} = \cdot 0243 \text{ tons per H.P.,}$$

or 2·43 tons for 100 H.P. Clearly the regulating power varies as the mass, as the square of the diameter, and as the cube of the revolutions per minute.

With violent load fluctuations, as in tramway work, the load may be entirely removed and half a revolution made before the driving power can be cut off by the governor.

Assuming an engine with an efficiency of 80 per cent., we have four-fifths of the work of half a revolution to be stored in the fly-wheel, and the percentage of speed increase will be as ⅘ of ½ to 0·228, or from 2 per cent. to $2 \times \frac{\cdot 4}{\cdot 228} = 3\frac{1}{2}$ per cent. above normal for that one-half revolution only. The author first gives the percentage divisor as double the total percentage variation, and afterwards as equal to this. Thus 1 per cent. from normal, or a range of 2 per cent., gives a divisor ·04, on the ground that resistance to velocity change varies as the difference of the squares of the maximum and minimum velocities, or as $\frac{W}{2g}$ (v^2 max. − v^2 min.). Later on he confirms this, and afterwards says that the divisor for a variation of 2 per cent. from normal is ·04, whereas it should be ·08 by his first statement.

Stresses in fly-wheels are next considered. The total stress at any point in a revolving rim is $\frac{W v^2}{g}$ where W is the mass of the rim in pounds and v is in feet per second. The unit stress is thus found by dividing by the cross-section. As the mass and strength both vary as the cross-section, it follows that for a given margin of safety every material has its safe limit, usually taken at 80 feet per second for cast-iron, which, however, is often called one mile per minute, or 88 feet. At this velocity the tension in a rim is 750 lbs. per square inch for iron, and this is the stress to be carried for every square inch of rim section by the fastenings; moreover, in a rim tied down to arms the segments of the rim may act simply as beams, and not be in ring tension at all.

Having ascertained what should be the dimensions of a fly-wheel, it remains, then, not to exceed them. Already the boss and arms are neglected, and, in high speed engines especially, the cyclic variation is usually diminished by the action of the moving parts. It should also not be overlooked that the effect of the piston and other rectilinearly moving parts may be considerable. Where, for example, load has been thrown off after steam admission, the engine tends to run away under the influence of the charge of steam and of the pressure exerted on the crank pin in the latter half of the stroke. This runs up the governor to the cut-off point, and on the next stroke there is not only no steam to keep the engine going, but a back pull by the heavy piston which absorbs energy in acceleration during the first half of the stroke. It is thus open to question whether in engines with very sudden load changes the excessively heavy moving parts of the Porter-Allen type of engine are desirable, however well justified for steady loads.

ELECTRIC DRIVING: ITS POSSIBILITIES AND LIMITATIONS.

There is no doubt that the determining factor in the development of electric driving is the cost of energy, and while this may be said to be practically settled in the case of large establishments where the cost per unit is never likely to be high, it is clear that no great impetus will be given to electric driving among small power users, unless the public systems of supply charge a low price for energy. It is doubtful how far a maximum demand indicator system aids in the development of motors on a town's supply, especially when the reduced price does not become effective till after the first two hours. No doubt there are many instances where the average work of an electric motor is less than an hour's run per day, and though a supply company or a municipality may airily say that they do not want such consumers, it is always a matter of regret to turn business away.

Mr. H. A. Mavor some little time ago, in a paper before the Glasgow section of the Institution of Electrical Engineers, discussed the question of electric driving, not so much as regards the economy effected as compared with other systems of transmission, but from the point of view of the machine itself. As the author points out, from the users' point of view, efficiency is usually a matter of secondary consideration, until the experience of comparative bills of cost induces a more intelligent inquiry into the relative values of the motors. If a careful series of tests were made on the efficiency of various motors on the market, we might be startled at the consumption of electrical energy per effective H.P.-hour. Small motors undoubtedly present many difficulties from both the manufacturers' and the consumers' point of view, and in order to meet some of these Mr. Mavor appears to favour the series wound motor for small sizes, especially when intended for high voltage. No doubt such a motor would have some advantages over shunt wound machines; it would appreciably affect the size of the starting resistance, but we should be inclined to doubt whether the series motor could be made so universally adaptable as the shunt machine. We are glad to see that Mr. Mavor tilts at the Insurance Companies on the subject of enclosed motors, for they are in many cases imposing the most absurd regulations. The author, however, suggests a method of dealing with the Insurance Companies which is worth quoting:—"The best way to deal with the companies in such

matters is, while treating them confidentially in the way of explaining what are the real dangers, and how they ought to be avoided, and giving them every encouragement to insist upon good workmanship, to be perfectly firm in refusing to adopt any absurd measures, such, for example, as placing motors on insulated non-combustible bases." No doubt enclosed motors are very desirable in certain cases, but to insist on them everywhere is quite unnecessary. In fact, we doubt very much whether all Fire Offices have a sufficient appreciation of what is dangerous and what is safe in a motor installation. As Mr. Mavor points out, the starting switch is a much more probable source of danger and, in fact, much yet remains to be done from the designer's and manufacturer's standpoint, to make the starting switch, even for small motors, a thoroughly satisfactory article. The liquid switches largely employed in connection with some of the electric lighting stations seem, on the whole, to give satisfactory results; but the arrangement is more cumbrous and expensive than it ought to be, and is too liable to get out of repair from corrosion or to become ineffective from evaporation of the liquid. The American types of wire starting switches, which have been largely imported into this country, are not satisfactory, and, in fact, the problem is still an open and unsolved one.

Attention has been more than once directed in these columns to the remarkable absence of data, regarding the application of electric driving to various industries. Occasionally, one is gratified by coming across attempts to systematise the results that have been attained under some conditions, but one never knows how far they can be applied to general conditions. Isolated attempts have been made to procure reliable information, but the facts that have been published, have been not always convincing. On one phase of the subject, however, that of transmission by shafting *v.* electricity, a Committee of the American Railway Master Mechanics' Association has made prolonged investigations and has embodied the results in an elaborate report, which we dealt with in our issue of September 28th. Appended to this report was the following table, which gives the power required for machine tools of various types, and which may be regarded as likely to be based upon reliable tests:—

Tool.	Nature of work.	Horse-power required. Empty.	Light load.	Full load.	No. of cutters.	Remarks.
70-inch wheel lathe	Wheel centre	...	4·4	7·9	2	Light cut.
	32-inch wheel centre	...	4·7	5·8	2	½-inch deep cut.
	56-inch " "	1·5	5·2	6·2	2	
Horizontal lathe	56-inch wheel centre	...	4·3	7·1	1	" "
Large double frame planer	Two frames	11·0	...	21·6	2	" "
Slotter, 18-inch stroke	Frames	2·3	5·0	10·3	1	Heavy cut.
" 12 " "	Wrought-iron, 6 inches thick	1·5	2·1	6·5	1	
36-inch planer	Frames	3·4	4·2	7·4	1	
		3·4	...	11·3	2	
Drill press	1-inch drill, wrought-iron	·97	1·94	2·9	1	
	1½-inch " "	·97	1·92	2·2	1	
	2½-inch " "	·97	1·94	2·85	1	
Boiler plate shears	$\frac{9}{16}$-inch plate, steel	3·5	6·0	19·0	1	
" " rolls	$\frac{11}{16}$-inch × 10 ft. 6 ins. long, steel	4·5	14·4	19·8	...	
Jib crane, 10-ton, 10-H.P. motor	Lifting 10 tons	1·2	...	13·0	...	
	" 7 "	1·2	...	11·0	...	
" 6-ton, 8-H.P. "	" 6 "	1·2	...	11·6	...	
Travelling crane, 5-ton	" and carrying 4 tons	11·9	...	19·3	...	
Planer	Empty	3·4	...	...	...	
	One tool	...	...	7·4	...	
	Two tools	...	...	14·0	...	
Shafting	Empty	15·0	...	...	...	
	Six planers	...	...	20·0	...	
	Four milling machines	...	...	26·0	...	
	Two lathes	...	...	30·0	...	
	One buff wheel	...	...	34·0	...	
Planer and siding machine	6-inch oak flooring	8·0	...	32·0	...	Top and sides planed.
24-inch planer	12-inch yellow pine	2·5	...	11·0	...	Top only.
Moulding machine	6½-inch yellow pine carlin	1·5	...	8·5	...	Four sides.
Daniel 30-inch head planer	Oak tender end sill	3·7	...	8·8	...	Cut $\frac{3}{16}$-inch off top.
Three-spindle boring mill	" 2-in. bitts	0·5	...	2·5	...	
Large tenoning machine	" end sills	3·0	...	7·0	...	3¾ inches × 5 inches ×
Circular rip saw, 28 inches diameter	" 9¾ inches × ¼ inch cut.	1·5	...	20·0	...	[10 inches cut.
Band saw blade, 1½ inches wide	" 12 inches thick	1·5	...	60·0	...	

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"J. C. G." writes:—"We shall esteem it a great favour if you will advise us through your Legal Column what to do under the following circumstances. Some two years since we laid down plant for producing half-tone blocks, running cable from the company's service to carry 2 H.P. motor, four pairs of 25-ampere arc lamps, and the necessary small lamps. Up to the present we have only been using the motor and one pair of arc lamps. We have lately ordered another pair of arc lamps, and on inquiry at the company's office for voltage, they inform us that the present voltage is 110 direct current, but they are altering the voltage to 220 volts, and without giving us any previous notice they will connect us in a month or so on to the cable carrying the 220 volts, and that we shall have to put, at our own expense, extra resistance coils to choke down the power, which we shall have to accept but cannot use through our lamps, or put down a transformer, which would cost us about £60. We should like you to let us know:—

"1. Are we obliged to accept the alteration in voltage?

"2. And if so, are we bound to pay the cost of extra coils or transformer?

"The manager of the company suggests that they must consult the Corporation, who have just taken over the electric supply, and see if they will put us in a transformer and charge us a rental; but he cannot decide this for the present."

*** The question put by "J. C. G." has already been dealt with on more than one occasion in the columns of the Electrical Review, but in view of its importance and of the somewhat peculiar features presented we are willing to consider it once more.

With regard to the first question, it appears that our correspondent is not bound to accept the alteration in voltage unless that change has been made "with the permission of the Board of Trade, and upon such terms as the Board of Trade may impose." The text of Regulation No. 5 of the Board of Trade Regulations, 1895, which relates to arrangements for supply made to consumers *after* 1895, is as follows:—"The standard pressure shall be fixed by the undertakers . . . . . and shall not be altered except by permission *of the local authority, and upon such terms and conditions as the local authority may impose.*" The words "*Board of Trade*" are substituted for "local authority" in orders made in favour of a local authority, and presumably, therefore, in cases where the undertaking is transferred to the local authority. By the next regulation it is provided that the pressure declared . . . . . shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure.

From the foregoing rules it is apparent that the Corporation has no power to force our correspondent to take the current at increased pressure, unless it has obtained the consent of the Board of Trade. Moreover, it is liable to penalties for refusing to comply with the regulations.

With regard to the second question addressed to us, we think that under no circumstances could "J. C. G." be compelled to pay the cost of extra coils and transformer in order to supply to the Corporation the means of furnishing current at increased pressure. To make a demand of this kind would be an unwarrantable exercise of their powers on the part of a supply company.

P.S.—Before "J. C. G." takes any steps to oppose the Corporation, we would recommend him to ascertain whether (*a*) the local authority consented to the alteration of pressure before, or (*b*) whether the Board of Trade gave their consent *after* the transfer of the undertaking. If such a consent has been given we fear he must suffer.

[We hope to deal with the letter addressed to us by a firm in Baker Street in our issue of next week.]

CURRENT SPECIFICATIONS.

XXXII.—BOOTLE EXTENSION PLANT.

SUMMARY.

Plant Required.—One steam dynamo, to have an output of about 250 KW.
Current and Voltage.—480 amperes × 520 volts.
Type of Engine.—Vertical compound condensing high speed type.
Output of Engine.—To run dynamo at full load when supplied with steam at 160 lbs. pressure, and exhausting to atmosphere.
Total Length of Combined Set.—Not to exceed 17 feet 9 inches.
Type of Governor.—Crankshaft centrifugal, acting on throttle valve, capable of controlling the engine within 4 per cent. from full to no load, to be capable of adjustment whilst running.
Type of Dynamo.—To be of usual "inverted" type, direct coupled to engine, and suitable for either lighting or traction work.
Range of Voltage.—440 to 525 volts at constant speed by means of shunt resistance.
Permissible Temperature Rise.—To be not more than 70° F. above surrounding atmosphere after six hours' run at normal full load.
Steam Consumption.—Not to exceed 23 lbs. per B.H.P. per hour at full load; 25 lbs. per B.H.P. per hour at three-quarter load; 28 lbs. per B.H.P. per hour at half load, when plant is running non-condensing and supplied with dry steam at 160 lbs. per square inch pressure at stop valve.
Combined Efficiency.—The combined efficiency of the set at full, three-quarters, and half load to be stated in tender.
Date of Completion.—August 1st, 1901.
Penalty for Late Completion.—*One per cent.* per week, or part of a week.
Terms of Payment.—80 per cent. on completion, 10 per cent. one month later, 10 per cent. at discretion of engineer until end of 12 months' period of maintenance.
Stipulations as to Removal of Foreman.—None.
Stipulations as to Wages paid to Workmen.—Satisfactory.
Arbitration Proposals.—Satisfactory.
Date for Receipt of Tenders.—October 13th, 1900.

This specification has been prepared by Mr. W. R. Wright, the borough electrical engineer, and in many respects it is among the best we have noticed in these columns. The requirements are clearly and tersely stated, and within wide limits the contractor is permitted to meet them in his own way. There are indications that a two-pole dynamo would be preferred in place of the usual multipolar, but contractors are at perfect liberty to offer their standard designs.

It will be noted that, though at present the plant will be worked non-condensing, the engine is to be in every way suitable for working condensing at a later date, without using an excessive amount of oil.

The steam consumption demanded, viz., that when working non-condensing, and supplied with steam at 160 lbs. pressure per square inch; at the engine stop valve 23 lbs. per B.H.P-hour at full load, 25 lbs. per B.H.P.-hour at three-quarter load, and 28 lbs. per B.H.P.-hour at half load, though fair are by no means unattainable.

Looked at from a technical standpoint, a plant could be supplied to meet the requirements of this specification which would be an excellent and economical machine at a reasonable cost, because no expensive deviations from standard patterns would be necessary.

While this latitude to the contractor is permitted as to design, the general conditions thoroughly guard the purchasers against inferior workmanship, for we find that :—

The whole of the material and workmanship must be of the best quality of their several kinds, and in every respect to *the satisfaction of the electrical engineer* for the time being of the Corporation, *who shall have full power to reject all or any of the materials or works which, in his opinion, are not in accordance with the specifications and plans* or these general conditions, or are defective for any reason whatever; and such materials shall be entirely removed by the contractor, or such defective workmanship shall be altered or re-executed by him within 24 hours or other reasonable time after written notice by the engineer to that effect; and in case of non-compliance by the contractor, the engineer shall have power to employ other persons to remove such materials and supply other materials in place thereof, or perform such alterations or re-execution of work; and any expense in so doing shall be defrayed by the contractor, or may be deducted from any moneys due, or to become due, to the contractor, or recovered by action, as the Corporation may be advised.

While making all reasonable demand as to rates of pay given to workmen, there are none of the irritating stipulations *re* overtime, notices in workshops, penalties for employers only for non-observance, &c., which render some of the specifications issued by public authorities so objectionable. The clause in question reads :—

In the carrying out of the contract the contractor shall be bound by the provisions in this clause contained *except so far as the contract relates to the supply of raw materials, patent articles and natural products.*

a. The contractor shall not sublet this contract except such portions of the work as would not be produced or executed by him in the ordinary course of his trade or business and which may be sublet by him to any person or firm approved by the Corporation subject to the provisions hereinafter contained.

b. The contractor or any such sub-contractor shall provide a sufficient number of workmen who shall be paid such rate of wages and observe such hours of labour as are the recognised standard of wages for competent workmen, and hours of labour respectively in the particular trade or trades engaged in the carrying out of the contract.

We see nothing in this which any of our leading firms need take exception to, and the exception of the contractor from enforcing labour demands upon the manufacturer of raw materials is an appreciation of the difficulties at present experienced in getting supplies which it is rare to find in public authorities.

The clause referring to arbitration is also acceptable. It is unlimited in its action, and provides for the reference of *any* dispute between the engineer and contractor to arbitration. It is drafted in a form which may well be copied in other specifications, for all the essential points asked for in the standard clause are conceded.

It states :—

In case *any doubt arises as to the intent and meaning of the specification* or plans, or these general conditions, or in case *any difference or dispute arises between the Corporation and the contractor*, the matter shall be referred to the engineer, but if the Corporation or the contractor refuse to accept the decision of the engineer, *the matter in dispute shall be referred to and be settled and adjusted by the President, for the time being, of the Institution of Civil Engineers*, or some member of the Institution nominated by him; *whose decision in all matters*, including the cost of such reference, *shall be final and binding on the parties hereto*, and the contract shall be deemed a submission within the meaning and for the purposes of the Arbitration Act, 1889.

SOME INTERESTING FAULTS MET WITH IN CABLE MANUFACTURE.

By J. WRIGHT.

A FAULT, whatever its nature, is at all times abhorrent to the electrician in charge of a network, but becomes more or less an object of interest when its position has been correctly localised, from the point of view indicated by cause, effect, and future prevention. In no branch of the profession are a greater variety of faults and their causes to be met with than in that of cable manufacture pure and simple; such faults arising, in process of manufacture, from carelessness on the part of the operatives, inadaptability of machinery to a specific purpose, or other unforeseen circumstances.

It is with the object of interesting the reader, and at the same time exhibiting the difficulties which the much-maligned and long-suffering manufacturer has perforce to contend with, that the following paragraphs have been written.

In rubber and gutta-percha insulated wires and cables, the faults most commonly met with are due to foreign matter and impurities in the insulating medium. Both rubber and gutta-percha, in the raw state, are essentially impure, owing to the local conditions governing their collection. For this reason they have perforce to undergo an exhaustive series of purifying processes before their final application to the cable or wire which they are intended to insulate, such as repeated washings in several waters, mastication, sieveing through a gradually decreasing mesh, &c., but despite these precautions, impurities will often find their way into the final result with disastrous effect. Cleanliness and care are essential in cable manufacture; the presence of any foreign matter, especially in gutta-percha, will make itself evident in the final tests, however slight its proportion to the total mass of insulation. Such faults as these, due to impurities, are seldom found by inspection, to a rigorous system of which most core is subjected in its unfinished state, with the single exception of

gutta-percha core, which, by its homogeneity of texture and monotone tint, readily lends itself to a minute visual inspection, which, with practice and experience as exemplified in some of the old hands in the trade, serves to eradicate most of the faults due to this cause. The remainder have to be localised electrically, to which end there are many systems, all more or less suitable according to local circumstances, and which lend themselves, in the majority of cases, to actual spot localisation.

Among the many impurities which find their way into rubber and gutta-percha compounds are wood, fibre, dirt, splinters of metal, mineral matter, &c., all of which, by their presence in the mass of the insulating sheath, tend to reduce its thickness, and, in many cases, form a direct conducting path from the conductor proper to the exterior of the core. The magnified appearance of a fault of this nature is represented in fig. 1, where *a* is the conductor, *b* the insulation,

Fig. 1.

and *c* the impurity causing the fault. In the example shown, the foreign matter, such as a fragment of wood, for example, is represented as forming a direct path from the conductor. A less prominent case is denoted at c^1, where the impurity is totally imbedded in the insulating sheath; this would, in all probability, not become apparent as a decisive fault, but rather make itself felt in a local reduction of the insulation resistance, owing to the lesser thickness of the otherwise uniform insulating sheath.

Now, as to how these impurities find their way into the insulating medium:—Ordinary dirt and impurities may be generally accounted for by insufficient washing and mastication, but minute splinters of wood, for instance, may be accounted for in a different way. The rubber, previous to its application to the conductor, is in the form of rolls of sheet, mounted on a cylindrical wooden mandrel in a lathe, for the purpose of cutting it by means of a knife tool into rubber tape of varying widths, in which condition it is applied to the cable or wire; if the tool be advanced too

Fig. 2.

deeply into the thickness of the roll its extremity reaches the wooden core, and in all probability cuts it slightly, the subsequent splinters, if the wood be soft, being commingled with the last layer of rubber. This cause of fault has been eradicated in many factories by making the cores of hard wood and dispensing with the final 6 inches, or so, of rubber tape, when running through the machine, an additional safeguard being provided in the shape of a stop to limit the depth of penetration of the cutting tool.

Fragments of metal, copper, tin, &c., are frequently separated from the conductor itself in the following manner:—The smaller sizes of strands and single wires generally are covered with rubber by compression, *i.e.*, the conductors, together with two strips of rubber one above and the other below, are passed between pairs of accurately turned hard steel rolls, which are grooved semi-circularly, such that at the point or line where they meet and revolve against one another, they form a complete circle equal in area to the cross-section of the finished or rubber-coated core. The seam or junction is secured to perfection by that property of freshly-cut rubber surfaces known as cohesion. Now, it is obvious that to secure centrality of the conductor it must pass absolutely through the centre of the circle formed by the groove in the two rolls; this is generally secured by passing it through frictionless guides, and also by maintaining the wire or strand taut between the limits of the machine by means of tension devices. Notwithstanding these precautions, it frequently happens in the case of stubborn wires or strands, such as 1/12 or 7/14 for example, that a slight kink in the bare conductor will pass between the rolls unnoticed, the existing tension being insufficient to straighten it. In a mild case, this usually results in throwing the conductor out of centre, as represented end-on in fig. 2, such that the insulation is very thin on one side and correspondingly thick on the other, which has an obviously deleterious effect upon the ultimate insulation resistance of the core.

In extreme cases, however, as with a bad kink, the periphery of the conductor itself passes at one point between the contact surfaces of the rolls, and is squeezed out into

Fig. 3.

a species of metal fin, surrounded on all sides by rubber, but usually with its extreme edge exposed, as represented in longitudinal section by fig. 3, where *a* represents the conductor as before, *b* the insulation, and *c* the fault.

Fibrous impurities, such as cotton, jute, &c., frequently occur, and, absorbing moisture by capillary attraction, provide direct conducting paths from the conductor to the exterior.

Another frequent cause of fault is the cohesive seam before alluded to, which requires to be subjected to perfect compression by two meeting surfaces to ensure its satisfactory production. If the rolls by which it is produced be not accurately surfaced and re-turned from time to time, the wear and tear consequent on frequent and daily use causes them to become untrue, with the result that they do not actually meet, and the subsequent seam is in consequence imperfect, and tends to open again at that point instead of becoming, as in the case of a perfect seam, homogeneous with the remainder of the insulating sheathing.

This cause may be practically eliminated by systematic inspection and overhauling of rolls, as now adopted in the leading cable factories.

A very frequent cause of local weakness in insulation is the absence of pure rubber at certain points along the core. The pure rubber, which is the first coating applied to the conductor in vulcanised rubber-covered cables and wires, is, especially in the smaller sizes, responsible for a considerable percentage of the ultimate insulation resistance, and, if conspicuous by its absence, tends to lower the final megohmic result obtained. This absence of the coating is explained as follows:—The pure rubber takes the form of a very thin coat applied spirally to the conductor under tension, *i.e.*, it is stretched in position, each turn or lap overlapping the last by an amount sufficient to produce a perfect homogeneous joint by the aforementioned property of cohesion. If the rubber should give way at any point through inherent weakness or careless jointing, its natural elasticity causes it to run back for a short distance, and so leave the conductor exposed. A bare portion of the conductor exposed in this manner may pass over unnoticed by the attendant, and receive its subsequent coating of compound rubber, which hides the original fault until it is exposed by the subsequent electrical tests. For this reason, what is known as a "double lap" of pure rubber, though slightly more expensive in prime cost, gives much better results, in that any spaces left by the first coating are almost invariably covered by the second layer. This cause of fault has now been almost entirely removed by a rigid system of visual inspection of the unfinished core both entering and leaving the machine.

A very common manufacturing fault met with in vulcanised rubber-covered cables is that caused by a flattening of the insulating sheath due to excessive pressure while in a plastic state. Most compound rubbers before vulcanisation are more or less of the consistency of putty, and, consequently, if subjected to any excessive weight or pressure, tend to flatten and lose their circular conformation. In order to undergo the process of vulcanisation, the taped core is wound on cylindrical metal drums, which are then placed in the vulcanising receiver. If an excessive length of core, running

into several layers, be wound on these drums, the upper layers tend to press and contract on the underneath ones, thereby producing a flattening of the insulation, which—the rubber being then in a plastic state—becomes permanent, and, in extreme cases, causes the conductor to become exposed by sinkage through the surrounding rubber. Two faults of this description are represented in transverse section in fig. 4, *a* being a mild case, and *b* an extreme one.

Fig. 4.

The taping, previous to vulcanisation, is also frequently responsible for certain faults, of which the following are typical specimens:—The "proofed" tape is applied spirally to the rubber-covered core under mild tension from a rapidly rotating "head." The tension is regulated by a nut and friction washer on the bobbin spindle; and if this be too tightly adjusted it causes the tape to draw in at its edges, and, by excessive pressure, cut into the surface of the plastic unvulcanised rubber, producing a fault, illustrated to a slightly magnified degree in longitudinal section by fig. 5.

Fig. 5.

A second taping fault which the writer has met with was due to the jointing of the tape, where one bobbin ran out, and another started. This jointing is sometimes effected by the application of a slight touch of pure rubber solution, or, in other cases, by hammering the two "proofed" surfaces together on a flat base, and trusting to cohesion to secure the joint. The fault under consideration was caused by the former method, in which a somewhat liquid solution had evidently been employed to excess; the overplus of naphtha, or other solvent, had in this case dissolved a large portion of the rubber immediately beneath the tape join, and thereby pitted the insulation in such a manner as to render it defective. Similar faults were experienced in this particular length of core at almost every tape joint.

Another result of tight taping is what is technically known as "spewing" of the rubber, which consists in the plastic rubber forcing its way under pressure of the encircling tape through the interstices of the fabric, and assuming a bead-like formation on the exterior surface of the core; in this manner the true thickness of the insulation is diminished, and its insulating qualities thereby impaired.

Broken wires and strands, especially in the smaller sizes, are a constantly recurring source of trouble in cable manufacture, mainly owing to the fact that almost all cable machinery is started and stopped on the "fast" and "loose" pulley system, a very erroneous one, under the circumstances, for this class of work. Almost all cable machinery, whether rubber-covering, taping, braiding, compounding, or armouring and serving, has a tension device of some kind, acting more or less directly on the cable attached to it, and the

Fig. 6.

result of a sudden start on a hitherto stationary conductor can be better imagined than described. Numerous faults arise from this cause alone, large cables, having a conductor diameter of ·5 inch or even more, being broken in this manner. In the case of small single wires, provided the shock be not very great, the broken extremities of the conductor are frequently held in intermittent contact by the inherent elasticity of the encireling rubber, which remains undamaged, thus giving greater trouble in localisation. The sectional appearance of a fault of this description is represented by fig. 6.

Breaks in small single wires are often the result of overheating or burning in jointing, the copper at that point being thereby rendered "short" or brittle. For a similar reason the use of an acid flux in soldering electrical conductors is tabooed, as the smallest trace of such a flux remaining on the finished joint will in time exercise a corrosive action on the metal thereof, tending in most cases to ultimate severance of the conductor, or, in any case, to the introduction of a high electrical resistance at that point.

Another form of fault which is occasionally met with in stranded conductors, especially when the conductor is of that particular quality technically known as "hard drawn," is that due to what is known as "bird cageing," which consists in a general tendency on the part of the component wires to unstrand, causing them to bulge out of their normal position and engulf the surrounding insulation. The appearance of a normal and "bird-caged" strand of seven wires is represented in transverse section by *a* and *b*, fig. 7.

Fig. 7.

Lead sheathing, which is so universally adopted as a mechanical protection for electric cables and wires, is responsible for several faults. In fibre-insulated cables, the imperviousness of the lead sheathing is the only guarantee of quality, in that a pinhole, extending through the thickness of the sheathing, will ultimately develop into a fault by the entry of moisture at that point. Such pinholes and flaws are frequently caused by the presence of minute quantities of red lead in the bulk of the metal, which passes through the press and ultimately presents the appearance of a small crack or flaw in the surface of the lead as represented in fig. 8.

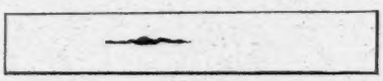


Fig. 8.

Other manufacturing faults in the lead sheathing process result from over-heating of the metal, &c., and frequently lead to the destruction of the actual insulating material while passing through the press.

The above-mentioned faults represent only a small percentage of the many which arise in process of cable manufacture, and are the result of observation on the part of the writer at some of the leading cable factories. They are in many cases responsible for the delay in execution and delivery of cable contracts, being, in the majority of cases, unforeseen, or due to carelessness on the part of the operatives. In some cases the fault lies with the customer, who, for the sake of a few shillings, will insist on a large single conductor or other erratic specification of his own personal conception instead of accepting the standard designs which have stood the test of time. In the writer's opinion, 1/14 is the safe limit for a single conductor; after that size is passed, stranded conductors should invariably be employed; they are more flexible, easier to manipulate, and carry a more reliable guarantee of quality than a single conductor of equivalent cross section.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

10,312A. "Improvements in and connected with wireless telegraphy." C. E. Wilson. (Date claimed under Patents Rule 19, June 5th, 1900.) Dated September 24th. (Complete.)

16,966. "Improved electromotor." A. E. Sauer. Dated September 24th. (Complete.)

16,988. "An improved electrograph." W. C. E. Faber. Dated September 24th.

16,998. "Improvements in or relating to trolleys for use in electric traction." J. G. Lister. Dated September 24th.

17,003. "An application of electricity to the imitation of snakes, reptiles and insects for theatrical and other purposes." C. Alias and J. J. Webber. Dated September 24th.

17,033. "An improved electric automatically indicating target for rifle practice." P. W. Merfield and E. Tozer. Dated September 25th.

17,049. "Improvements in coin operated electric meters." F. Kraemer and E. Weber. Dated September 25th. (Complete)

17,077. "Improvements in arc lamps." H. S. Dodd and R. I. Bagnall, jun. Dated September 25th.

17,110. "An arrangement of connections for sets of electric glow lamps in series so as to maintain the circuit in case of the extinction of one or more of the lamps." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated September 26th. (Complete.)

17,125 "Electric generators for military and other cycles." H. V. Weyde. Dated September 26th.

17,128. "Improvements in magneto-telephones." H. E. Newton. (Parnell, Rabbidge, New South Wales.) Dated September 26th.

17,131. "Improvements in and relating to incandescence electric lamps." C. A. Henry. Dated September 26th.

17,135. "Improvements in electrodes for accumulators." H. J. Haddan. (R. Goldstein, Germany.) Dated September 26th.

17,154. "Improved mode of attaching glass shades to electric light and the like fittings." J. A. Ellis. Dated September 27th.

17,160. "Improvements in electrical fuse-boxes." A. D. Smith. Dated September 27th.

17,172. "Improvements in electric switches." V. G. Lironi. Dated September 27th.

17,174. "Improvements in carbon brush holders for dynamos." Siemens Bros. & Co., Limited, Germany. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated September 27th.

17,184. "Improvements in electric switches." J. M. Hewitt and W. G. Rhodes. Dated September 27th. (Complete.)

17,194. "A fusible alloy specially adapted for use as an electrical circuit breaker." R. Pearson. Dated September 27th.

17,211. "Improvements in electric conductors, casings, or conduits." L. Marsh. Dated September 28th.

17,234. "Improved means for generating variable electromotive force." J. E. Miller. Dated September 28th. (Date applied for under Patents, &c., Act 1883, Sec. 103, March 1st, 1900, being date of application in United States.)

17,246. "Improved prepayment of electricity meter with coin-freed control mechanism." B. Avena. Dated September 28th. (Complete.)

17,262. "Improvements in electricity meters of the electrolytic type." A. Wright and The Reason Manufacturing Company, Limited. Dated September 28th.

17,289. "Improvements relating to automatic electric switches." A. H. Adams. Dated September 29th.

17,293. "An improved thermo-regulator or thermostat." R. Kann. Dated September 29th. (Complete.)

17,294. "Improvements in or relating to electric telegraph or telephone instruments." A. J. Boult. (A. Bannerman, South Africa.) Dated September 29th.

17,310. "Improvements in apparatus for the generation and electrolytic application of electric currents." F. E. Elmore. (Partly by J. O. S. Elmore, India.) Dated September 29th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

22,600. "Improvements in incandescent electric lamps." The British Thomson-Houston Company, Limited. (G. B. Painter.) Dated October 27th, 1898. Relates to incandescent lamps. A cap connected to one leading-in wire, is filled with plaster or other material, in which is set a central hollow pin connected with the other wire. The pin is made by pressing a flat strip of brass to a cylindrical form, but with the ends flaring somewhat; a hole originally at the middle of the strip receives the leading-in wire, and a depression formed about the hole receives solder by which this wire and the pin are connected. 2 claims.

22,603. "Improvements in prepayment electricity meters." F. M. Long and E. Schattner. Dated October 27th, 1898. Improvements upon the invention described in Specification No. 14,107, A.D. 1898. A large resistance is put between the two mercury cups, so that the light is not extinguished, but only sufficiently diminished when the current prepaid has been supplied. 4 claims.

22,622. "Improvements in or relating to electrolytic baths." J. Marino. Dated October 27th, 1898. Glycerine is used, entirely or partially, in place of water in the electrolyte. If the salts used are directly soluble in glycerine, no other solvent is required; but when not soluble or only slightly so at ordinary temperatures, either the glycerine is heated, or other solvents, such as alcohol, potash, acids, &c., are used, glycerine being added either with the solvent or subsequently. The glycerine is not decomposed by the current, and moreover prevents the water or other solvent from being decomposed. Suitable salts and acids may be added to increase the conductivity of the bath. Metals and alloys may be deposited by this method, the following being mentioned:—Silver, zinc, copper, iron, aluminium, lead, antimony, arsenic, nickel, tin, copper, aluminium bronze, tin bronze, and Britannia metal. 2 claims.

22,664. "New or improved appliances for use in securing the copper bonds or conductors in electric tramway rails." E. M. Munro, H. Brocknell, and H. J. Rogers. Dated 28th October, 1898. Relates to rail bonds. Dies used for inserting and securing rail bonds are made in two parts so that they can be easily applied to embrace the bond and to bear on the shoulders of its head. The form and connection of the two parts may be modified from that shown. 1 claim.

22,686. "Improvements in magnetic brakes." S. Pitt. (Elektricitats Aktiengesellschaft vormals Schuckert & Co.) Dated October 28th, 1898. The invention is shown applied to a railway vehicle. The pole-pieces move axially within the fixed bobbin carriers so as to make frictional contact with the brake disc. The circuit of the magnetic lines of force is made through the parts and through a casing similar to a dynamo frame. 2 claims.

22,699. "Improvements in dynamo-electric machines." W. B. Sayers, H. A. Mavor, and Mavor & Coulson. Dated October 28th, 1898. Relates to machines of the kind described in Specifications 16,572, 1891; 10,298, 1893; 27,209, 1896; and 5,177, 1898, wherein sparking at the commutator is prevented by the use of "commutator coils." According to the present invention, the edges of each pair of poles which act upon the commutator coils at the time of commutation are arranged at a distance apart rather greater than that between one side of one commutator coil and the opposite side of the next commutator coil, or next but one, two, or more coils. At the same time the tread of the brushes is correspondingly varied. Thus the period of time occupied by the reversal of the current during commutation is increased, and greater efficiency is obtained. In order to produce a regulating effect without the use of a compound winding on the field magnet, each of the commutator coils may be so arranged that one of its sides is at a greater distance than the other from the point of connection with the armature winding. 2 claims.

22,700. "Improvements in the manufacture of tubes or conduits or the like, more especially intended for containing electric cables or conductors." H. Edmunds. Dated October 28th, 1898. Tubes or conduits for electric conductors, water supply and other purposes are formed of Portland, &c., cement, lined with bitumen, &c. The cement may be formed on a bitumen lining, or the bitumen may be run liquid into the tube. 1 claim.

22,768. "Improvements in methods of and apparatus for increasing the volume of sound from telephonic or phonographic instruments and transmitting such sounds to distances." H. L. Short. Dated October 29th, 1898. Relates to methods of increasing the volume of sounds whether produced or received by electric telephones, mechanical telephones, phonographs and similar instruments, fog-horns, speaking tubes, sirens, alarms for fire-station use, signalling on board ship, light ships, and lighthouses, for the constructions of musical instruments and for other purposes. The principle involved consists in operating some form of valve so as to vary the passage of compressed air, steam, &c., in accordance with the vibratory motion of a diaphragm, &c., acted upon by the voice or by a phonograph cylinder or disc, &c. The vibrating air may itself issue from a trumpet mouthpiece, or may still further operate a larger valve and the process be again repeated by means of connecting links and levers acting on further valves, diaphragms, &c. Several modifications of the instruments are described embodying various shaped valves and arrangement of the valve rods. A diaphragm is connected to a valve rod having a seating capable of closing the opening in the air chamber. A second larger valve operates the rod connected to the producing apparatus, the compressed air escaping by a pipe after having its vibrations augmented by the face of seat acting with the central opening in valve. The air chamber is provided with a grid valve directly connected to a sound trumpet for fog-horns, &c. The sliding rod in connection with a phonograph stylus. The principle of sound magnifying is applied to a phonographic musical instrument in which rings of vibrations are recorded on a phongraph cylinder, several rings for notes of different quality being arranged for each note of a scale. Contact-styles are arranged on valves around the cylinder corresponding in number to the rings to each note. The sets of styles can be thrown into and out of gear by cam rods as desired. The compressed air, after passing through the valves, is conveyed by channels to an annular chamber leading to a sound trumpet. The supply of air to the valves is controlled from a key-board provided with the necessary stops. 17 claims.

22,777. "An improved light distributor or reflector for electric incandescence lamps." C. Feldmann. Dated October 29th, 1894. Bowls or reflectors for electric incandescent lamps. A small bowl of ground, cut, or opal glass, is placed within an ordinary reflector to prevent projection of an image of the filament by the reflector. 1 claim.

22,784. "Improvements in electric railways or tramways on a road contact or like system." J. D. F. Andrews. Dated October 29th, 1898. Electro-magnets are carried by an endless belt running on pulleys on the vehicle, and are excited by current from a battery or by the motor current, &c., so as to actuate switches at the road contacts or conductors, which may be in insulated sections. The belt may be in insulated sections, supplied with current by brushes or other arrangements, and are made so that the magnets are only excited when they are on the underside of the belt and lying on the switch boxes. The switch may consist of an iron cover-plate and a movable magnetisable plunger connected to the main conductor through a spring. The conductor may, however, be flexible and made of iron, or provided with iron magnets adapted to be lifted by the vehicle magnets to contact with the cover-plates, or other forms of switches may be used. 2 claims.

22,802. "Improvements in or connected with reflectors for incandescence electric or other lamps." L. J. Steele, Sir J. B. Maple, Bart., M.P., and J. Verity. Dated October 29th, 1898. Porcelain, glass, or other reflectors for incandescent electric or other lamps are coated or filled with phosphorescent or fluorescent materials, such as phosphide of calcium or alkali metals, phosphorus paste, sulphide of calcium or barium, oyster shells calcined with sulphur, heavy spar heated with gum tragacanth, fused potassium nitrate, sulphur, or saccharine. Reflectors such as are described in Specifications Nos. 22,803 and 23,402, 1898, are coated internally. 1 claim.

22,803. "Improvements in or connected with incandescence electric lamps." L. J. Steele, Sir J. B. Maple, Bart., M.P., and J. Verity. Dated October 29th, 1898. Incandescent lamps with central reflectors. The reflector and bulb are made of crystal or other glass not containing lead or other materials, such as are acted upon in use, and cause the lamp rapidly to become inefficient. A ring of metal covered with asbestos or other material is placed on the reflector, and is movable by shaking the lamp or by a magnet, to clean it. The reflector may be hollow, and contain a phosphorescent powder; it is perforated, and exhausted with the bulb, a plug of asbestos being inserted to prevent escape of the powder through the hole. The reflector and ring may be placed in another tube as described in Specification No. 23,420, A.D. 1898, and this is also provided with a cleaning ring. 2 claims.

22,858. "Combined apparatus for regulating the supply of electricity to lamps, motors, and other electrical apparatus." E. E. Prestwick and L. N. Burt. Dated October 31st, 1898. Relates to regulating the supply of current to mutiple circuits, containing lamps or motors, &c., and is especially applicable in theatres. A resistance, either a choking coil or an ohmic resistance is inserted in each circuit. For use with alternating circuits, a number of choking coils are arranged in the circuits, and the coils may be moved simultaneously or in combination. On a shaft are fixed a set of notched wheels, and loose pulleys, the latter carrying cords connected to the cores. The pulleys carry telescopic handles fitted with detents by which any on or set of pulleys may be locked to the shaft. The shaft is rotated by worms or other gearing. For continuous currents, adjustable resistances replace the choking coils, the cores carrying contacts for short circuiting the coils when in the lowest position. 3 claims.

22,872. "Improvements in electrolytical apparatus." J. Leiselet. Dated October 31st, 1898. A compartment or chamber is formed of a frame of wood or other non-conducting material, with walls of porous material, such as vulcanised fibre and of perforated sheets of metal or other conducting substance. The sides may be secured to the frame by counter-sunk screws. The conducting plates form the electrodes when the chamber is immersed in a chamber containing conducting liquids. Several apparatus may be connected together in parallel or in series. 2 claims.

22,884. "Improvements in or relating to means for making electrical connections." Dr. E. Andreas. Dated October 31st, 1898. A connection particularly adapted for the lugs of accumulator plates, consists of a ring of hard lead which embraces the lugs, the whole being pressed together to give a good connection by a wedge, also of hard lead. 4 claims.

25,746. "Improved means for electrically heating ovens, hot chambers, rooms, and the like." F. Christy and L. F. Christy. Dated December 6th, 1898. A heater consists of an angular support of wire gauze, perforated metal, porcelain, or slate, the metal being covered with asbestos, mica, enamel, or other refractory insulator, upon which a resistant strip or wire is coiled. The heater is supported, and electrically connected at its ends by screw clamps or the like, carried on insulators so that the heater may be readily replaced by another. Such heaters may be used as radiators for warming rooms, or for other purposes. An oven may be provided with one heater near the top, and two on the bottom. To prevent drippings from fallings on the latter two, a sheet of metal is placed above them, having holes punched in it, and bent to the form shown. The heat produced may be regulated by switches placing one or more heaters in circuit, using electrical or optical temperature indicators, or automatically by expansion or resistance variation. 2 claims.